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GOVERNMENT OF THE REPUBLIC OF [illegible]

MINISTRY OF NATURAL RESOURCES

FEASIBILITY STUDY

ON

THE AGRICULTURAL DEVELOPMENT

IN THE [illegible] BASIN

MAIN REPORT

[illegible]

JAPAN INTERNATIONAL COOPERATION AGENCY

GOVERNMENT OF THE REPUBLIC OF HONDURAS
MINISTRY OF NATURAL RESOURCES

FEASIBILITY STUDY ON THE AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN

VOL. I MAIN REPORT

MAY 1978

JAPAN INTERNATIONAL COOPERATION AGENCY

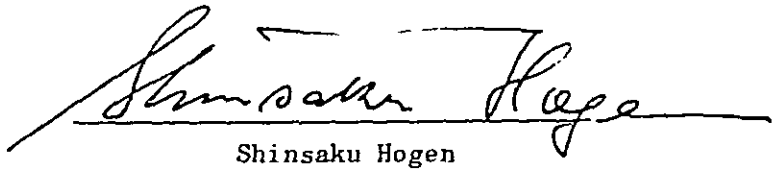
FOREWORD

The Government of Japan, in response to a request from the Government of the Republic of Honduras, decided to conduct a feasibility study on the Agricultural Development Project in the Choluteca River Basin. The Japan International Cooperation Agency, the executive organization of overseas technical cooperation programs, dispatched to Honduras a preliminary survey mission headed by Mr. J. Ishizaka of the Ministry of Agriculture and Forestry in March 1977 and another mission for the feasibility study headed by Mr. I. Kuno of Nippon Koei Co., Ltd. from July to October of the same year.

In this report are described the results of the feasibility study on the above-mentioned project. I hope that this report will contribute not only agricultural development in the Choluteca river basin but also an overall agricultural development of Honduras.

Finally, I wish to express my sincere gratitude to the persons of the missions, the authorities concerned of the Government of the Republic of Honduras, the Embassy of Japan in Honduras, the Ministry of Foreign Affairs and the Ministry of Agriculture and Forestry, for their close cooperation afforded for the preparation of the report.

Tokyo, May 1978



Shinsaku Hogen
President
Japan International Cooperation Agency

May, 1978

Mr. Shinsaku Hogen
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Hogen,

LETTER OF TRANSMITTAL

We are pleased to submit the feasibility study report on the Agricultural Development in the Choluteca River Basin located in southern Honduras. In the report are fully incorporated the advices and suggestions of the Advisory Committee specifically set up in Japan for the study of the above-mentioned project, as well as the comments raised by the Ministry of Natural Resources of the Government of Honduras during the final discussion on the draft report held at Tegucigalpa in early april 1978.

The project is basically formulated for the agricultural development by drastic production increase of sugar cane, cotton and basic grains, providing irrigation and drainage facilities for 16,000 net hectares in the Choluteca coastal plain by constructing a storage dam at the San Fernando site on the Choluteca river. Power generation at the San Fernando dam with an installed capacity of 14,000 kW is also envisaged in the project. A stagewise project implementation is technically possible, and the first stage development is proposed to irrigate 12,400 net hectares without power generation.

The economic internal rate of return of the proposed project is estimated to be 12.2 percent for the full scale development and 9.1 percent for the first stage development. In view of the importance and urgency of the project for the development of agriculture in southern Honduras, as well as for socio-economic development of the country as a whole, we recommend that the Government of Honduras will take up the project for implementation.

We wish to take this oportunity to express our sincere gratitude to the personnel of your Agency, the Advisory Committee, the Embassy of Japan in Honduras, the Ministry of Foreign Affairs and the Ministry of Agriculture and Forestry. We also wish to express our heartfelt gratitude to the counterpart experts of the Ministry of Natural Resources and other authorities concerned of the Government of the Republic of Honduras for their close cooperation and assistance extended to us during our field survey.

Very truly yours,

I. Kuno

Ichiro Kuno
Team Leader
Nippon Koei Co., Ltd.

SUMMARY

BACKGROUND

1. The Republic of Honduras has a population of about 2.8 million with an annual growth rate of 2.7 % on the land of 112,000 km^2. The terrain is ragged and mostly consisting of highlands of 1,000 - 3,000 m in elevation. The climate is tropical in the lowlands and moderate in the highlands.

2. The gross national product (GNP) was $1,160 million or $414 per capita in 1976. The economy depends on less diversified agriculture which is largely affected by periodic draught and floods. Agricultural products account for 30 % of the GNP, and over 60 % of employed population are engaged in agriculture.

3. Bananas and coffee together share 40 - 60 % of the total export value. Banana production was maintained at a level of more than one million tons but it dropped to 770,000 tons in 1975 due to the serious damage of the Hurricane Fifi in 1974. Coffee production has been 29,000 - 54,000 tons, showing an increasing trend. Sugar production capacity is about to increase from 88,000 tons to 272,000 tons. Cotton farms have expanded from 3,300 ha to 10,300 ha in recent 5 years reflecting the expansion of export. It is expected that sugar and cotton will increasingly contribute to the diversified export.

4. The production of grains including maize, sorghum, rice and beans has largely fluctuated depending on the climatic conditions and it remains at an average level of 420,000 tons. As the result, Honduras has recently turned from an exporter to an importer of grains. If the present population growth rate persists, Honduras will have to import some 170,000 tons of grains in 1985.

5. The highest priority has been given to the agricultural sector in the 5-year economic development plan of Honduras for 1974-1978. The major policies are the improvement of agricultural income in the lower income group, creation of employment opportunities in rural areas, increase of agricultural products and maximum use of natural resources. Under the

Agrarian Reform Law (Decreto-Ley No. 170) which was promulgated in 1975, about 66,000 ha of lands have been re-distributed to 21,600 farmers.

6. Cultivable lands in the whole country is limited to about 2 million ha, about a half of which will be unsuitable for large scale development. The northern region has long been exploited for banana plantation, while the southern region remains less developed.

THE CHOLUTECA RIVER BASIN

7. The Choluteca river basin covers 7,580 km^2 in the southern region. The river cuts deep but fairly wide valleys in the mountainous upstream basin. Hill soils are thin and coarse, often contain rock fragments and boulders. Alluvial and terrance soils covering the Choluteca coastal plain of 700 km^2 have the greatest potential of agricultural development in the basin.

8. The annual rainfall in the overall Choluteca river basin is estimated at 1,013 mm on an average. Rainfall during the rainy season from May to October accounts for 90 % of the annual precipitation. Annual runoff of the Choluteca river is 1,948 million m^3. The dry season runoff is as low as 3-4 m^3/s in March and April. The long dry spell constrains agricultural production in the basin.

9. There are 7 irrigation establishments totaling 1,470 ha in the middle reach valleys and 2,190 ha in the coastal plain, taking water from the Choluteca main stream. A study on water balance in the basin implied the fact that the river had been over-exploited and the irrigated lands in the coastal plain were already in short of water. Tube wells in the coastal plain have problems of little yield and difficult operation and they are only supplemental for irrigation of 2,230 ha. The agricultural development in the Choluteca river basin needs a storage reservoir to augment the dry season flow.

THE PROJECT

10. The Agricultural Development Project in the Choluteca River Basin is envisaged in 22,400 ha (gross) in the western part of the Choluteca coastal plain. The objectives of the Project are set as follows:

(1) Sugar cane production of 800,000 tons to meet the demand of sugar mills in the coastal plain,

(2) Grain production of 35,000 tons which will meet the food demand in 1985 in Choluteca and Valle Departments, together with 22,000 tons to be produced outside the Project area,

(3) Increased production of vegetables and horticultural crops to improve the diet and to increase small farmers' income,

(4) Cotton production for diversification of industrial crop and increase in farmers' income,

(5) Irrigation to the Monjaras-Buena Vista and Ola resettlement schemes where possible.

11. The gross project area of 22,400 ha encompasses, at present, 8,540 ha of crop land, 11,420 ha of pasture, forest, bush and scrub, 420 ha of villages and 2,040 ha of road, water, etc. The land should be cultivated for crops to the maximum extent in the light of productive soils. The net irrigable area is estimated to be 16,000 ha. Three major existing pumps will be incorporated in the Project, sharing 1,630 ha, but other area under surface and tubewell pump irrigation will be shifted to be covered by the proposed plan for irrigation.

12. A storage dam is required to be constructed at the San Fernando site located about 20 km north of Tegucigalpa. The recommendable dam height is higher than that of minimum requirement for only the irrigation purpose, on account of optimum utilization of power potential incidental to the dam. The annual inflow is 425 million m^3 from the catchment area of 1,665 km^2. The San Fernando dam of 93.5 m in height will create a reservoir of 330 million m^3 in an active storage capacity with a storage area of 22 km^2. This reservoir will irrigate the Project area of

16,000 ha, as well as 8 irrigation schemes of 1,680 ha in the middle reach valleys of the Choluteca river. The proposed power station with an installed capacity of 14 MW will generate 58.4 GWh of energy annually.

13. The proposed irrigation system includes intake weir at El Papalón located at the upstream end of the coastal plain; main, branch and secondary canals totaling 158 km, main and secondary drainage canals of 144 km, main and secondary roads of 122 km and on-farm facilities including certain land reclamation where necessary.

14. Since a major hindrance to agricultural development is the shortage of water during the dry season, little improvement in crop yields or in cropping patterns is expected under the future without-project condition, except the sugar cane production which is assumed to be increased to meet the demand of sugar mills by shifting over 60 % of the present pasture or forest lands of 10,930 ha in the Project area to sugar cane fields. Under the with-project condition, on the other hand, the required sugar cane fields will be smaller owing to higher yield, and it will be possible to largely increase other crop production by shifting most of the present pasture and forest lands to crop fields as well as by introducing dual croppings under the proposed irrigation farming. The livestock raising will be shifted to hilly areas. The agricultural production in the Project area is estimated under the present condition, future without-project condition and with-project condition as follows:

Unit: tons

Crop	Present	Without-project	With-project
Sugar cane	382,000	800,000	800,000
Maize, sorghum & rice	3,800	3,800	33,200
Beans	0	0	1,600
Cotton	1,500	1,500	15,300
Sesame	200	200	1,200
Melon, water melon & vegetables	3,100	3,100	23,400

15. The financial investment cost for the proposed Project is estimated for both the foreign and local currency components as summarized below:

Unit: $ million

	F.C.	L.C.	Total
Dam & power station	22.81	10.37	33.18
Irrigation system	11.67	11.45	23.12
Engineering & administration	8.00	1.00	9.00
Land compensation	-	0.82	0.82
Sub-total	42.48	23.64	66.12
Physical contingency (10 %)	4.25	2.36	6.61
Price contingency (5 %/year)	9.71	5.58	15.29
Total	56.44	31.58	88.02

The project will be implemented in 6 years from 1978 to 1983 including the financial arrangement, detailed engineering and construction. The investment will be disbursed as follows:

Unit: $ million

Year	F.C.	L.C.	Total
1978	1.84	0.22	2.06
1979	5.35	3.38	8.73
1980	9.17	4.40	13.57
1981	22.07	13.82	35.89
1982	16.28	7.20	23.48
1983	1.73	2.56	4.29
Total	56.44	31.58	88.02

16. A part of the project benefit will accrue from 1983 when the dam, power station and majority of irrigation system will become operational, and the full benefit will be expected in 4 years after the completion of the Project. The annual benefit under fully developed stage is estimated at 1977 price levels from the economic point of view as follows:

	Unit: $ thousand
Project irrigation benefit	9,280
Project power benefit	2,230
Production forgone in the reservoir area	- 110
Associated irrigation benefit	1,200
Total	12,600

The economic cost at 1977 price levels was derived by deducting the transfer payments and price contingency from the financial cost as shown below:

Unit: $ thousand

	Investment	O & M
Dam	30,920	120
Irrigation facilities	26,910	1,080
Power facilities	7,610	110
Associated irrigation facilities	4,250	150
Total	69,690	1,460

The economic internal rate of return is estimated to be 12.2 %, which justifies the economic feasibility of the Project. A sensitivity analysis shows that the internal rate of return is 8.1 % even in the case that the benefit is reduced by 10 %, the cost is increased by 20 %, and the completion of the Project is delayed by one year.

17. Farmers' capacity-to-pay is estimated by type of land holding group at 1977 price levels as summarized below:

Unit: $ thousand

	Settlers	Less than 50 ha	50 ha-200 ha	More than 200 ha	Sugar cane estate	Associated areas
Average farm size	4.1 ha	13.4 ha	68.2 ha	200 ha	3,530 ha	5 ha
Gross income	6.6	24.3	113.2	342.8	3,915	7.1
Production cost	2.7	11.2	56.4	169.4	2,232	2.9
Net farm income	3.9	13.1	56.8	173.4	1,683	4.2
Living expense	1.2	1.2	5.4	6.4	-	1.2
Capacity-to-pay	2.7	11.9	51.4	167.0	1,683	3.0

18. In the financial analysis of the Project, benefits are estimated on the basis of the total value of farmers' capacity-to-pay in the Project area of 16,000 net ha and associated area of 1,680 ha, and the energy sales at the primary substation priced to be 35 mills/kWh for the primary energy and 19.5 mills/kWh for the secondary energy. It is assumed that the benefits and costs are escalated at an annual rate of 5 % up to 1983 and no inflation is considered from 1983 onward. The financial rate of return is calculated to be 11.7 % for an evaluation period of 27 years from 1978 to 2004.

19. A financial statement was prepared assuming the following conditions:

(1) The local currency component of current investment cost of the Project and the whole investment cost of the associated facilities will be financed from the government budget.

(2) The foreign currency portion of project investment cost will be financed by an external loan at an interest rate of 5 % with a repayment period of 27 years including a grace period of 7 years.

(3) Farmers will bear $50 million out of the total investment cost of the Project and associated facilities at the time of completion of the Project. They will repay this amount at an interest rate of 10 % with a repayment period of 20 years including a grace period of 2 years.

(4) The O & M cost for irrigation will be collected from farmers in the Project area and associated project areas as water charge.

(5) The current surplus will enter in the government asset for the repayment of foreign loan, recovery of government budget and replacement.

It was found that the foreign loan will be paid off in 27 years and expenditure from the government budget will be recovered within 20 years. The farm budgets under the present condition and under with-project condition at 1977 price levels are compared, assuming that the water

charge and farmers' share on capital are distributed in proportion with the net farm size, as shown below:

Unit: $ thousand

	Settlers	Less than 50 ha	50 ha- 200 ha	More than 200 ha	Associated areas
Present Condition					
Average size surveyed	5.8 ha	12.6 ha	87.4 ha	401.5 ha	-
Gross income	2.2	3.2	20.7	84.7	-
Production cost	0.7	1.3	13.3	52.8	-
Net farm income	1.5	1.9	7.4	31.9	-
Taxes	0	0	0.6	10.9	-
Living expense	1.2	1.2	5.4	6.4	-
Net Surplus	0.3	0.7	1.4	14.6	-
With-project Condition					
Average income	4.1 ha	13.4 ha	68.2 ha	200 ha	5.0 ha
Gross income	6.6	24.3	113.2	342.8	7.1
Production cost	2.7	11.2	56.4	169.4	2.9
Net farm income	3.9	13.1	56.8	173.4	4.2
Water charge	0.3	1.1	5.7	16.6	0.4
Loan repayment	1.1	3.4	17.6	51.5	1.3
Profit	2.5	8.6	33.5	105.3	2.5
Taxes	0	0.6	4.5	28.2	0
Living expense	1.2	1.2	5.4	6.4	1.2
Net surplus	1.3	6.8	23.6	70.7	1.3

20. It is concluded that the proposed Agricultural Development Project in the Choluteca River Basin is technically sound, economically justifiable and financially viable. It is recommended that the Government of Honduras implement the Project in view of the fact that the project is the proper measure to meet the urgent need for the agricultural development in the southern region of Honduras.

21. It is technically possible to implement the project by stages. In case the first stage development is contemplated to irrigate 12,400 net ha in the project area with an initial dam height of 80 m, which can be heightened in the future stage, the total investment cost will be $63.91 million as summarized below:

Unit: $ million

	F.C.	L.C.	Total
Dam	13.34	8.03	21.37
Irrigation system	10.26	9.42	19.68
Engineering & administration	5.80	0.80	6.60
Land compensation	-	0.62	0.62
Sub-total	29.40	18.87	48.27
Physical contingency (10 %)	2.94	1.89	4.83
Price contingency (5 %/year)	6.55	4.26	10.81
Total	38.89	25.02	63.91

This first stage development will be already sufficient to supply the whole sugar cane requirement in the Choluteca plain and to increase the agricultural production, which will result in a substantial increase in farmers' income. The estimated internal rate of return of the first stage is 9.1 %, which implies that the first stage development itself is economically viable even in such a case that further development is assumed to be suspended. The selection between the full scale development in one stage and the staged development will depend mainly on the financial circumstances.

22. Various unquantified benefits could be derived from the Project as stated below:

(1) The proposed San Fernando dam and reservoir will have flood control effects, and it would also create possibilities of water supply to Tegucigalpa utilizing the reservoir as water source, tourism development, fish farming, etc.

(2) Another development center will be created under the Project in the southern region of the country which at present remains less developed than the northern coastal area of the country.

(3) The increase in exportable sugar and cotton production under the Project will contribute to a diversification of exportable products.

(4) Construction, operation and maintenance of the Project facilities will create working opportunities to the people in the central and southern regions of the country.

A MULTIPURPOSE PROJECT

23. A multipurpose dam project was studied at Morolica II site located at about 50 km upstream from the El Papalón intake weir site. The annual inflow is 1,215 million m^3 from the catchment area of 6,370 km^2. Seemingly the best scale of the project is a rockfill dam of 93 m in height with an active storage capacity of 600 million m^3. A power installation of 60 MW and irrigation system of 16,000 ha are envisaged. The investment cost is estimated at $150 million and the internal rate of return is calculated to be 11.5%. This project is presented for the consideration by the Government if the power demand would become urgent problem in the near future or if further irrigation development in the coastal plain (eastern part) would be taken up after the development of the proposed project.

PRINCIPAL FEATURE OF THE PROPOSED PROJECT

1.	San Fernando Dam & Power Station	
	Reservoir	
	Catchment area	1,665 km^2
	Annual inflow	425 MCM
	Active storage capacity	330 MCM
	Reservoir area	22 km^2
	High water surface	EL. 823.5 m
	Dam & Power Station	
	Dam type	Concrete gravity
	Crest elevation	EL. 829 m
	Dam height & volume	93.5 m, 310,000 m^3
	Spillway capacity	2,470 m^3/s
	Installed capacity	14 MW
2.	Choluteca Plain Irrigation System	
	Net area commanded by new irrigation system	14,370 ha
	Net area commanded by existing pumps	1,630 ha
	Net irrigable area total	16,000 ha
	Village, water, road, etc.	6,400 ha
	Gross project area	22,400 ha
3.	Investment Cost	$88.02 million
4.	Output	
	Sugar cane	800,000 tons
	Maize, sorghum & rice	33,200 tons
	Beans	1,600 tons
	Cotton	15,300 tons
	Other crops	24,600 tons
	Annual energy output	58.4 GWh
5.	Small Irrigation made Possible by the Project	8 nos., 1,680 ha
6.	Economic Internal Rate of Return	12.2 %

PRINCIPAL FEATURE OF FIRST STAGE DEVELOPMENT

1. San Fernando Dam	
Reservoir	
Active storage capacity	135 MCM
Reservoir area	13.7 km^2
High water surface	EL. 807.5 m
Dam	
Dam type	Concrete gravity
Crest elevation	EL. 815 m
Dam height & volume	79.5 m, 225,000 m^3
Spillway capacity	3,300 m^3/s
2. Choluteca Plain Irrigation System	
Net area commanded by new irrigation system	10,770 ha
Net area commanded by existing pumps	1,630 ha
Net irrigable area total	12,400 ha
Village, water, road, etc.	4,900 ha
Gross project area	17,300 ha
3. Investment Cost	$63.91 million
4. Output	
Sugar cane	800,000 tons
Maize, sorghum & rice	19,800 tons
Beans	800 tons
Cotton	9,000 tons
Other crops	14,200 tons
5. Small Irrigation made Possible by the Project	2 nos., 340 ha
6. Economic Internal Rate of Return	9.1 %

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CONVERSION FACTORS AND ABBREVIATIONS

1) Length

mm = millimeter
cm = centimeter
m = meter
km = kilometer

2) Area

Mz = 0.7 ha = Manzana
ha = 10^4 m^2 = hectare
km^2 = square kilometer

3) Volume

ℓ = lit = litre
kℓ = kilolitre
m^3 = cubic meter
MCM = million cubic meters

4) Weight

mg = milligram
g = gram
kg = kilogram
t = 1,000 kg = ton

5) Time

s = second
min = minute
h = hour = hr
d = day
yr = year

6) Money

$ = US dollar
L. = Lempira = $0.5

7) Electrical Measures

H = Hertz (cycle)
KW = Kilowatt
MW = Megawatt
KWh = Kilowatt hour
MWh = Megawatt hour
GWh = Gigawatt hour
KVA = Kilovolt ampere
MVA = Megavolt ampere
rpm = revolution per minute
P.F. = Power Factor

8) Other Measures

ppm = parts per million
% = per cent
PS = Horse power
pH = scale for acidity
oC = degree centigrade
10^3 = thousand
10^6 = million
10^9 = billion (milliard)
EL. = elevation above mean sea level

9) Derived measures are based on the same symbols:

m^3/s = cubic meter per second
t/ha = ton per hectare
KWh/yr = Kilowatt hour per year

10) Others

GDP = Gross Domestic Product
GNP = Gross National Product
IECO = International Engineering Company. USA
JICA = Japan International Cooperation Agency
FAO = Food and Agriculture Organization of the United Nation
MRN = Ministry of Natural Resources
INA = National Agrarian Institute
BNF = National Development Bank
ENEE = Empresa Nacional de Energia Electrica
ACENSA = Azucarera Central S.A.
ACHSA = Azucarera Choluteca S.A.
ACANSA = Azucarera Cantarranas S.A.

1. INTRODUCTION

1.1 History of the Project

A land and water resources development project was proposed in the Choluteca Project Feasibility Report (Ref. 1) prepared by the International Engineering Co. (IECO), U.S.A. in 1968. The project envisaged irrigation of 15,500 ha for upland crop cultivation and power generation of 6 MW in the Choluteca river basin, but it has not been implemented for a decade.

With the recent policy directing the increase in agricultural production, the Government of the Republic of Honduras requested the Government of Japan in 1976 for technical cooperation in review and updating of the previous study on the Project.

A pre-project mission dispatched by the Government of Japan in March - April 1977 stated in their report (Ref. 2) that the agricultural development in the Choluteca river basin had a high priority in view of the economic development of Honduras, and the previously studied project would be better reformulated on account of the recent development in various aspects.

The Government of Japan decided to take up a feasibility study for the agricultural development in the Choluteca river basin under its technical cooperation program. The Japan International Cooperation Agency (JICA) was appointed as the executing agency of the Government of Japan and it entrusted the feasibility study to Nippon Koei Co., Ltd. in July 1977.

1.2 Work Performed

The field survey was carried out by a Nippon Koei team in collaboration with the counterparts of the Ministry of Natural Resources (MRN), Honduran Government, from mid-July to mid-October 1977. The geological drilling in the field was continued till mid-January 1978. A field report (Ref. 3) was submitted in October 1977 summarizing the

findings in the field and the schedule for analysis of data and compilation of the final report. The participants in the field survey are listed in Table 1.

A detailed study and analysis have been carried out subsequent to the field work, and all results of the work are presented in this Feasibility Report.

The field survey was basically supplementary to IECO's study, including the collection of new data pertaining to meteorology and hydrology, a check-up survey for the soil and dam site geology, a survey of the present situation of agricultural land use, agro-economy, irrigation, agro-industrial development, institution and supply-demand balance, and investigation of the present farming practice and crop yield. In the detailed study and analysis, the development potential of land and water resources in the whole Choluteca river basin has been evaluated for agricultural development and a project for immediate implementation is proposed.

1.3 General Settings of the Project

Honduras needs investment to increase production on the agricultural land, which is quite limited by rugged terrain, under the economic structure dominated by agriculture. Southern valleys are relatively less developed than the northern valleys, though they have good potential for agricultural development. The macroscopic objective of agricultural development in the Choluteca river basin is the exploitation of agricultural potential in the coastal plain and open valleys in the southern Honduras.

The recent construction of sugar mills in the Choluteca river basin has called for a substantial shift of crops to sugarcane. The resettlement based on the Agrarian Reform Law (Decreto-Ley No. 170, 1974) is redistributing the lands owned by limited landlords to a number of farmers. The nation's food demand has increased with a high rate of population growth. All these conditions require higher productivity of land, while agriculture still remains extensive.

The soils in the Choluteca valley especially in the vast coastal plain are suitable for cultivation. The primary hindrance to agricultural development is a long dry spell in which rain ceases and rivers are depleted.

The project is envisaged for sugar cane and grain production in the Choluteca valley through the year-round cultivation providing irrigation with a storage reservoir.

2. BACKGROUND

2.1 Geographic Features of Honduras

Honduras has an area of 112,000 km^2, and is located approximately between latitude 13° and 16°30' north and between longitude 83°10' and 89°20' west. The mainland is bounded by the Caribbean Sea to the north, Nicaragua to the southeast, the Gulf of Fonseca to the South, El Salvador to the southwest and Guatemala to the west.

The terrain consists mostly of highlands with elevations between 1,000 m and 3,000 m above sea level, except for the northeastern corner. A deep structural valley cuts through the highlands between the Ulúa valley and Gulf of Fonseca. The southern highlands are covered by Tertiary volcanic rocks with south-bound drainage systems.

The climate is hot and wet without notable variation. It is cooler at higher elevations. Rainfall is high especially in the east. It varies significantly on the southern coast and inland but is more consistent on the Caribbean coast. The rainy season is from May to October.

There are extensive forests of hardwoods in the east. Pine and oak grow in the highlands. Savannas develop where mountain ranges shut off rain.

2.2 Administrative Division and Population

The territory of Honduras is administratively divided into 18 Departments which are further subdivided into Municipios. Tegucigalpa, capital city, and its vicinity is called as Distrio Central being located in Francisco Morazan Department.

The population in Honduras was about 2,657,000 according to the 1974 census. Its annual growth rate was relatively high, or 2.7% between 1961 and 1974 censuses. If this growth rate persists, the population will grow to about 3.6 million in 1985. The area and 1974 census population in each Department are shown in Table 2.

Major population centers are Tegucigalpa (305,000) and Santa Rosa de Copán (20,000) in the highland; San Pedro Sula (201,000), Puerto Cortes (44,000), Tela (47,000), La Ceiba (48,000) and Trujillo (20,000) are the centers in the northern coastal region; Choluteca (49,000) and San Lorenzo (13,000) in the southern region.

2.3 Economy of Honduras

The economic structure of Honduras is agricultural. The gross national product (GNP) was $1,159 million or approximately $414 per capital in 1976 (Table 3). The annual economic growth rate was 3% on an average between 1971 and 1976. It was maintained between 3.8 and 5.0% in 1970 - 1973 but it dropped to 0.6% in 1974 and -0.6% in 1975 due to the damage to banana plantations by Hurricane Fifi in 1974. The growth rate recovered to 6% in 1976.

The gross domestic product (GDP) at current factor cost was $738 million in 1972, $813 million in 1973, $898 million in 1974, $949 million in 1975 and $1,073 million in 1976. Table 4 shows GDP by industrial origin from 1970 to 1976. The sectorial composition of GDP has changed little. The agriculture, silviculture, fishery and hunting sector has the greatest share in GDP. It accounted for 35% of GDP at factor cost in 1971 - 1973 but it dropped in 1974 - 1976. The lowest share of 29% was marked in 1975. The contribution of mining and manufacturing sectors has slightly increased; from 16% in 1970 to 20% in 1976.

According to the 1974 census, 762,000 people were employed in various economic activities out of the total population of 2,657,000. The population employed in the agriculture, forestry, livestock and fishery sector account for 461,000 or 60% of the total employed as shown in Table 5.

Table 6 shows the balance of payments of Honduras. The export of goods and services was $217 million or 32% of GDP at factor cost in 1971. It increased to $428 million or 40% of GDP at factor cost in 1976. The import of goods and services has always exceeded exports. In consequence, the current account has remained in deficit. Expecially the deficit

amounted to $106 - $120 million in 1974, 1975 and 1976. The deficit has been met by foreign capital inflow which was $30 million in 1971 and $144 million in 1976.

Table 7 shows the export value by commodity. The majority is unprocessed agricultural products. Bananas are the most important export item, though its export value has dropped since 1974 due to flood damage.

Imports doubled in the last five years as shown in Table 8. Most import items are manufactured goods. Import of food products made up about 8 - 10% of the import value.

The consumers' price has been rising moderately except for the boom in 1974 as the price index in Table 9 indicates. The annual inflation rate was 7% on an average between 1971 and 1976, or 5% except for 1974.

2.4 Agricultural Production

The major agricultural products in Honduras are bananas, coffee, maize, sorghum, beans, cotton and sugar. The composition of GDP in the agriculture, silviculture, fishing and hunting sector in 1970 - 1973 was as shown in Table 10. The production volumes of major agricultural products are shown in Table 11.

Bananas have been the major plantation crop mainly developed in the northern region since 1950s. It earned a half of the export value in early 1970s, 70 - 80% of the product being exported mainly to U.S.A. Exports exceeded 1×10^6 tons in 1971 and production marked 1,550,000 tons in 1972. Production and exports have, however, declined in recent years due to serious hurricane damage in September 1974. Banana production decreased to 770,000 tons in 1975. The production of coffee has been 29,000 - 54,000 tons. Its export volume also has accounted for 60 - 80% of the production owing to favorable world market conditions. Bananas and coffee together share 40 - 60% of export value, the high price of coffee counterbalancing the recent decline in banana export. Because these products are largely dependent on the weather and price

fluctuations, diversification of agric ultural products is indispensable for stable economic development.

Honduras has three sugar mills in operation; CAHSA and Azucarera Chumbagua in the northern region and Azucarera Choluteca in the southern region. Their sugar production capacities total 88,000 tons. Four additional sugar mills are going to be completed in the near future: Azucarera Yojoa and Azucarera del Norte in the northern region, and Azucarera Central and Azucarera Cantarnanas in the sourthern region, and the existing mills are scheduled to increase their capacity. With these expansion programs, the total sugar production capacity will increase to 272,000 tons in the near future as shown in Table 12. The sugar export was 10,000 tons in quantity, or 2.3% of total export value in 1975. It is expected that these figures can be increased more than ten times in the future. Sugar will substantially contribute to the diversified export in the future.

Cotton farms expanded from 3,300 ha in 1970/71 to 10,300 ha in 1976/77, reflecting a remarkable increase in the export of cotton raw. The domestic textile factories are forced to import cotton raw under the impact of cotton export. Cotton will also be a promising export item.

Regarding grains, the production of maize and sorghum has largely fluctuated depending on climatic conditions, and it has remained at an average level of 370,000 tons for a long time. Beans production has a declining trend, while rice has been increasingly produced. As a whole, grain production remains at a level of 420,000 tons. Honduras exported a substantial volume of grain until the beginning of 1970s, but it turned to a grain importer recently under pressure of high increase in population as shown in Table 13. It is estimated that Honduras has to import 170,000 tons of grain in 1985, if the production stands at the present level. The shortage will be 230,000 tons in a dry year. Self-sufficiency of staple food would be attained if grain production increases at a rate of 4% annually.

Honduras is going to diversify crops for export and it needs more grain production, but cultivable lands are limited. Good agricultural soils and flat lands are limited to the northern coastal plain, some

major inland river valleys and the southern coastal plain where the Choluteca Plain is located. The remaining lands are predominantly steep ragged terrain with limited potentials for stable cultivation of crops of high yields. Potential land use study by FAO suggested that some 2 million ha or about 18% of the total land of the country is suitable for agriculture. Large scale land development is further limited to roughly one half of the cultivable areas because of soil conditions or steep slopes. More than 90% of crop and pasture lands are rainfed. Droughts and floods have led to large fluctuations in agricultural production. Furthermore, drought and flood damages have usually kept productive development behind. High and stable production can be attained only through an intensive cultivation with adequate irrigation and drainage provided.

2.5 Government Policies for Agricultural Development

According to the 1965 - 1966 agricultural census, small land holders of less than 5 ha, accounting for about 68% of the total holders, occupied only 12% of the total land in farms. In January 1975, the Agrarian Reform Law (Decreto-Ley No. 170) was effected with the objectives of offering land to landless or small-holding farmers to secure their participation in socio-economic development and of organizing and extending to them technical and financial assistance. Under the agrarian reform, for instance, land holding in the Choluteca plain is limited to 500 ha and holding under state irrigation system to 100 ha in principle. (Land in bananas, sugarcane, coffee, African palm, citrus, pineapple and tobacco is not subject to expropriation as long as efficient production is maintained.) The National Agrarian Institute (INA) is functioning as an executing agency for land reform, and the Ministry of Natural Resources (MRN) and the National Development Bank (BNF) are cooperating in extending technical assistance and agricultural credits.

Farmers under INA programs are settled in groups (asentamientos) and work on a cooperative basis. Under the Agrarian Reform Law (Decreto-Ley No. 170), about 66,000 ha have been expropriated for some

21,600 families up to September 1976 (Area expropriated in South Region during this period was limited to only 830 ha). INA programmed for 1977 newly to incorporate about 60,000 ha for 12,000 families. In fact, a greater number of the settlements have been successful, but some proved ineffective due mainly to adverse natural conditions and educational deficiencies of the settlers.

The Government of Honduras has a 5-year plan (1974 - 1978) for economic development of the country. The plan has objectives to i) increase incomes, especially those of rural population, and attain their equitable distribution, ii) decrease unemployment, iii) get maximum benefits from processing of products and modernize related industries, iv) rationalize natural resources development, v) diversify and increase domestic production, and vi) strengthen national economic positions in the international market. The plan aims at an average GDP increase of about 6% during the period, but it will not be attainable due to the worldwide recession after the oil crisis, damage caused by the 1974 hurricane, rural income stagnation, shortage of infrastructures, deficit domestic entrepreneurship and so forth.

Under the 5-year plan, the agricultural sector is programmed to play the most important role among various economic activities. The major issues in the agricultural sector have been i) to improve agricultural incomes for lower income groups, ii) to create employment in rural sector, iii) to accelerate agricultural output, iv) to diversify exports, and v) to develop natural resources to obtain maximum benefit for the country.

3. LAND AND WATER RESOURCES IN THE MIDDLE REACHES OF THE CHOLUTECA RIVER BASIN

3.1 General Features of the Choluteca River Basin

The Choluteca river basin of 7,580 km^2 is located in the eastern part of the Tertiary volcanic rock zone. The Choluteca river originates in the ridge of 1,400 - 2,000 m in elevation to the south of Tegucigalpa. Passing through Tegucigalpa, it runs to the north. It is joined by the Hombre river from the left near the Hernando Lopez bridge on the Olancho highway and then takes its course to the east towards San Juan de Flores. The Choluteca river thereafter runs to the southeast to the vicinity of Oropoli and turns its general course to the southwest toward Choluteca collecting the Texiguat river on the right bank near Morolica. Traversing the Choluteca plain, the river discharges into the Gulf of Fonseca. The basin map is shown in Plate 1.

The Choluteca river basin is mountainous, the elevations generally ranging between 500 m and 2,500 m. Rivers cut deep but fairly wide valleys. The Choluteca river has a narrow gorge in the section of 8km below theHernando Lopez bridge. The Choluteca plain of about 700 km^2 is mostly less than 40 m in elevation.

The rocks in the Choluteca river basin are composed mainly of acidic pyroclastic rocks of various grain sizes ranging from volcanic breccia to fine tuff, some of which are welded. Lava flows of rhyolite, andesite and basalt are also prevalent.

Hill soils are thin and coarse textured. They often contain rock fragments and boulders. Alluvial and terrace soils develop in narrow strips along rivers and in the Choluteca plain. They are deep and generally show hydromorphic weathering.

The climate of the Choluteca river basin is characterized by the dry season from November to April and the wet season from May to October with interruptions in July and August. The rainfall during the wet season is about 90% of the annual. The annual rainfall varies from

place to place. It is 1,000 mm in the upstream region, 800 mm in the middle region and 1,900 mm in the coastal plain. The basin average rainfall is estimated to be 1,013 mm. The annual variation of air temperature is small, of 3 - 4°C, but the daily variation ranges from 8 to 12°C. The annual mean temperature depends on the altitude. It is 22°C at Tegucigalpa at about 1,000 m in elevation and 28°C at Choluteca in the coastal plain. The annual mean relative humidity is 72% at Tegucigalpa and 65% at Choluteca.

The annual runoff in the Choluteca river is 1,948 x 10^6 m^3. Reflecting the uneven distribution of rainfall, the runoff in the dry season is very low. In March and April, the discharge in the Choluteca decreases to 3 - 4 m^3/s and most tributaries are depleted.

The predominant agriculture in the Choluteca river basin is grain and stock farming under rainfed conditions. The crop yield is generally low. Sugar cane and cotton farming is going to increase in the alluvial and terrace soils in relation to the recent development of sugar mills and ginning factory.

The major cities in the Choluteca river basin are Capital Tegucigalpa (274,000), Yuscaran (2,000) and Choluteca (26,000). The Pan-American highway passing Choluteca has a connection at Nacaome with the national highway to Tegucigalpa. From Tegucigalpa to the north a highway connects Comayagua and San Pedro Sula and another highway leads to Olancho Department via Talanga. New highways were constructed connecting Tegucigalpa with Talanga and Danli. A new port is being constructed with storages and loading facilities of sugar, cotton and molasses at San Lorenzo between Choluteca and Nacaome. A 230 kilovolt power transmission line is connected with Nicaragua power system, passing Tegucigalpa, Nacaome and Choluteca.

3.2 Irrigation Establishment in the Middle Reaches of the Choluteca River

There are 6 irrigation establishments in open valleys in the middle reaches of the Choluteca river basin. Their total area is 1,650 net ha, mainly depending on the main stream of Choluteca (Plate 15).

The San Juan de Flores area is located approximately between San Juan de Flores and Villa de San Francisco. The soils are alluvial and terrace soils of fine loam. MRN established an irrigation system of 1,140 net ha on the right bank in 1966. The system has an intake weir in the Choluteca river and canal system. A pumping station was recently constructed. The present crop is entirely sugar cane. Because the irrigation system has deteriorated, MRN started the rehabilitation of the facilities at the beginning of 1978 with a budget of $690,000 utilizing a loan of $640,000 from the Central American Bank for Economic Integration.

The Oropoli area is a depression at about 5 km northeast of Oropoli. An irrigation system of 180 net ha is being constructed by MRN. The crops are maize and sorghum. The system depends for water on a tributary.

Herein called Orocuina area is the alluvial and terrace plain gently undulating along the Choluteca river in a 25 km long stretch between Apacilagua and Choluteca. There are 6 irrigation projects of 330 net ha in total being operated by cooperatives under the INA program. The largest is 210 net ha established at Las Sabilas with the assistance by FAO, where rice and maize are grown. Others are small, being 17 - 45 ha in net area. All these projects pump water from the Choluteca river.

The existing irrigation establishments in the middle reaches of the Choluteca river are listed in Table 14.

3.3 Irrigation Development Possibilities in the Middle Reaches of the Choluteca River

As the topographic features indicate, intensive cultivation on alluvial and terrace soils having appropriate water resources will increase the capacity to support the expanding population and agro-industries, while the elevated and sloped lands will remain under extensive cultivation. For increased agricultural production, the alluvial and terrace land should be irrigated for year-round cultivation of grain and industrial crops where possible. Stock farming in the alluvial and terrace land should be shifted to the hilly or mountainous lands.

The irrigation project should be planned depending on the main stream of Choluteca, because tributaries are depleted for a long time in the dry season. The possibilities for the irrigation development in the middle reaches of the Choluteca river total 8 in number and 1,680 ha in net area as shown in Table 15. Proposed layout of irrigation facilities is shown in Plate 15. (for general location see Fig. 2).

A sugar factory of Azucarera Cantarranas (ACANSA) is going to be commissioned with a capacity of 1,814 tons/day at the end of 1977 near San Juan de Flores. The annual sugar cane requirement is estimated to be 270,000 tons which is twice as much as the cane production from 1,140 ha, even after the rehabilitation of MRN's irrigation system. 270 gross ha on the left bank near the Paso La Ceiba bridge are presently occupied by maize and pasture under rainfed conditions. Pumping from Choluteca river can irrigate 230 net ha in this area for sugar cane production of 27,000 tons. (This irrigation project is herein called San Juan de Flores A). A sugar cane field of 110 net ha is inadequately irrigated by a small tributary near the right abutment of MRN's intake weir. Rehabilitation of this irrigation system including the construction of a pumping station in the Choluteca river will result in sugar cane production of 13,000 tons. (San Juan de Flores B).

Even if these two irrigation projects are completed, ACANSA will need 100,000 tons of additional cane. Since there is no farther irrigation possibility in the vicinity, about 1,500 ha of rainfed farm will also be required.

The Morolica area consists of recent alluvial plains developed on the left bank of the Choluteca river near Morolica. The present land use is maize and pasture cultivation in 190 ha. Herein pump irrigation schemes of 210 net ha (Morolica C) and 90 net ha (Morolica D) are proposed for grain crop.

Four additional irrigation projects are proposed in the Orocuina area; Orocuina E (150 net ha), Orocuina F (250 net ha), Orocuina G (100 net ha) and Orocuina H (540 net ha) for mainly grain production.

3.4 Water Resources

There are 12 water level gauging stations in the Choluteca river basin; 7 in the main stream and 5 in the tributaries. Among them Hernando Lopez station and Los Encuentros station are important because of long records, relative accuracy of records and the locations near the proposed dam and intake sites.

Hernando Lopez station of 1,565 km^2 in catchment area has the monthly discharge record from August 1954 to December 1959 and June 1964 to April 1976 with some interruptions since 1972. Los Encuentros station of 6,370 km^2 in catchment area has the monthly discharge record from November 1956 to December 1959 and August 1964 to October 1973. The discharges in the interrupted periods were estimated based on the rainfall runoff relationship. The records for the two stations are presented in Table 16 and 17.

The average annual runoff is 399 x 10^6 m^3 at Hernando Lopez and 1,251 x 10^6 m^3 at Los Encuentros. The runoff in 5 months between December and April is only 6 - 7% of the annual runoff. The lowest flow occurs in March or April. It is 1.5 m^3/s at Hernando Lopez and 4 m^3/s at Los Encuentros on average. Even the wet season discharge is very low in some years due to the lack of rainfall. For instance, the annual runoff in 1972 was only 106 x 10^6 m^3 at Hernando Lopez and 384 x 10^6 m^3 at Los Encuentros. The natural runoff in the Choluteca is low and uncertain, being unfavorable for use.

As will be described in 4.8, there are 9 irrigation establishments of 2,030 net ha in total area depending on the Choluteca river in the Choluteca plain. Taking into account these and the 1,650 ha in the middle reaches, the water balance in the Choluteca river basin was examined. The critical period for irrigation is April. A drought occurring once in ten years was assumed. The irrigation system in each area withdrew water at a rate of the estimated diversion water requirement. A certain return flow is expected, but neglected in the water balance calculation. The resulting water balance at each stretch of Choluteca river is as shown in Fig. 1. The river flow is marginally

enough for the irrigation of 1,140 ha in the San Juan de Flores. Water is sufficient in the Orocuina area. It is definitely insufficient in the Choluteca plain.

3.5 Alternative Damsites

The natural flow has already been over-exploited for irrigation. Storage supplement by the construction of a dam is indispensable to maintain dependable water supply to the existing irrigation establishments as well as to prepare for the further irrigation development.

The alternative damsites investigated for the feasibility study were the Zorrillo, San Fernando, Morolica I and Morolica II damsites. Their features follow.

3.5.1 Zorrillo Damsite

The Zorrillo damsite is located at the inlet of a narrow gorge about 500 m downstream from the Hernando Lopez bridge on the highway of Olancho. The catchment area is 1,590 km^2. The valley walls on both banks rise up from the riverbed of El. 755 m of northeast course to EL. 810 m where slopes become gentler. There is a saddle in the northwest of the left bank hill needing a dike for storage. Rocks are rhyolitic welded tuffs hard to moderately hard in outcrops. Vertical joints develop strongly. The drill logs prepared by IECO show that there are numerous open voids of 2-4 cm in diameter below the riverbed. The rocks have different solidities due to the original nature. Underlying bed may be softer than the overlying. The rock excavation of 10-12 m in depth and foundation grouting will be necessary for dam construction. The reservoir area is wide open valley with mild slope of massive Tertiary tuff showing no problem of leakage or large scale sliding.

3.5.2 San Fernando Damsite

The San Fernando damsite is located about 2 km downstream from the Zorrillo damsite. The annual inflow from the catchment area of 1,665 km^2 is 425 x 10^6 m^3. The river channel of 20-30 m in width turns its

course from northward to eastward as the right bank protrudes at the damsite. The riverbed is at EL. 740.5 m. Both banks are 70 - 80° in slope up to terraces at EL. 835 m. The terrace widths are 50 m on the left bank and 200 m on the right bank, continuing to high mountains. The rocks are rhyolitic welded tuffs having vertical joints. A fault line is assumed along the gully behind the terrace on the right bank. A geological map is shown in Plate 5 and a geological profile along the proposed dam axis is compiled in Plate 6.

As a result of core drilling No. SF-1 at EL. 835 on the left bank, core recovery was less than 50% from the ground surface to the depth of 15 m. There are slight weatherings and few openings at a depth of 22-25 m. High Lugeon value of 18 units at 30 m in depth suggests open cracks developing to some depth.

The drill core in No. SF-3 on the terrace at EL. 835 m on the right bank showed that the rocks are moderately hard near the surface but weathered to the bottom of 48 m in depth. Some voids and traces of water were recognized.

The core drilling in No. SF-2 at EL. 770 m on the left bank revealed that there is a thick bed of green altered tuff at a depth of between 9 and 22 m below the riverbed. This altered tuff is horizontally stratified and comparatively dense and massive but liable to break. It trends to slake or collapse when soaked in water in unconfined conditions. The underlying rocks are solid grey muddy tuff and propylitic tuff.

The rocks are cracky but the leakage problem can be solved by excavation to an appropriate depth and foundation grouting. The altered tuff bed below the riverbed should not be exposed by excavation because of slaky nature. The shearing strength is low, estimatedly around 10 kg/cm^2.

As for the construction material, sand is obtainable from the river deposit upstream from the Hernando Lopez bridge. River gravels are unusable because they contain a high proportion of soft tuffaceous gravel. The nearest source of coarse aggregate will be the hard dacite flow about 10 km from the damsite. The available volume is more than 400,000 m^3.

Rock material will be obtained from hard welded tuff bed within 3 km in distance. However there will be certain loss because of the varying hardness of welded tuff. Clay material cannot be obtained in sufficient volume.

A concrete dam will need a wide base because of low shearing strength in the foundation. A fill type dam will have a problem of high cost in rock material and unavailable clay material.

There is no problem of leakage or large scale sliding in the reservoir area.

3.5.3 Morolica I Damsite

The Morolica I damsite is located about 5 km west southwest of Morolica. The riverbed is about 100 m in width at EL. 175 m. The left bank slope is about 45° up to EL. 280 m. The right bank slope is steeper than the left bank up to the terrace at EL. 270 m. The Morolica I damsite is the narrowest in the vicinity. The base rock is greenish coloured tuff, containing angular fragments of andesite and felsitic material, with low to moderate hardness. It is exposed on the left bank slope. The drilling No. MI-3 in the riverbed showed fresh tuff bed overlain by sand, gravel and boulders of 9 m in thickness. Mudstone is intercalated below a depth of 25 m. The right bank is covered by thick Quaternary mud flow of angular to sub-angular debris of rock of mainly rhyolite. Two holes, MI-1 and MI-2, were drilled near the outcrops of tuff on the right bank flat but they could not reach the bed rock at a depth of 30 m and 60 m. The outcrops of tuff are, therefore, judged as moved rock mass. Because of deep excavation on the right bank for the foundation, this site is unsuitable for dam construction.

3.5.4 Morolica II Damsite

This site is located about 7 km downstream of the Morolica I damsite. The annual runoff from the catchment area of 6,187 km^2 is $1,215 \times 10^6$ m^3. The riverbed at EL. 150 m is 200 - 250 m wide having a 60 m wide low water channel. The left bank is at a slope of about

30° on a hill of maximum 860 m. The right bank has a slope of 45° up to a minor peak of EL. 320 m. There is a depression of EL. 290 m between the minor peak and a peak of EL. 500 m behind it.

Drilling MII-1 in the riverbed confirmed existence of a solid andesite bed composed of dark coloured, fine and dense, basic or basaltic andesite and irregularly intercalating dacite under 12 m thick gravel and boulders. The andesite is overlain by the upper volcanic breccia composed of sub-granular fragments and blocks of basalt and andesite with brownish grey tuffaceous matrix materials in the upper part of slopes; above EL. 275 m.

The andesite bed is solid and water-tight, suitable for the rockfill dam. Excavation of 10 m to remove talus deposit and loose rock will be required for the foundations of impervious core on the right bank. The excavation depth on the left bank will be several meters.

Fine aggregate will be obtained in the riverbed. For the coarse aggregate and rock material, the slopes of andesite on both banks within 600 m upstream from the dam axis are possible quarry sites. The excavated material from the structural foundation can also be used. Clay material is scarce.

The reservoir area is underlain by massive Tertiary tuffs, the valley is generally wide and the hills are thick. There is no possibility of leakage. The Quaternary mud flow deposit between Morolica and the damsite especially the steep slope on the right bank of the Morolica I damsite need careful study in view of land sliding.

So far investigations to date indicate that the San Fernando damsite is better than the Zorrillo damsite, because the valley is narrower and the geological condition is rather better. Therefore, the Zorrillo damsite is regarded as the alternative to the San Fernando damsite if any serious default would be found at the San Fernando damsite in the detailed investigation. The Morolica I damsite was investigated because it was very likely to provide a less expensive dam than the San Fernando damsite in view of the wide reservoir area, larger

catchment area and closer location to the Choluteca plain. It was, however, found that the proposed right abutment is covered by loose and thick Quaternary mud flow so that this site is unsuitable for dam construction. The Morolica II damsite has wider valley topography than the Morolica I site, but its rocks are sound and suitable for dam construction. In consequence, the storage possibilities in the Choluteca river will be studied at the San Fernando and Morolica II damsites. More detailed description of dam site geology and results of geological drilling are compiled in ANNEX C and ANNEX K.

4. THE CHOLUTECA PLAIN

The vast Choluteca coastal plain is the most important area for agriculture in the Choluteca river basin, while the land development possibilities in the middle reaches are rather limited. The present situation of the Choluteca plain is described hereunder.

4.1 Physiography

The Choluteca plain is approximately bounded by the Pan-American highway in the north and by the Sampile river in the east. It faces the Gulf of Fonseca in the south and west. A belt of about 7 km from the sea coast is a coastal flood plain which was not included in the feasibility study because the soils are saline. Consequently, the surveyed Choluteca plain has a gross area of 36,300 ha between 5 and 35 m in elevation. The Choluteca river takes its course to the west for about 12 km from Choluteca and then turns to the south meandering toward the sea. It has an old river course on the right bank near the bend to the south.

Most of the right bank of the Choluteca river and the lower reach of the left bank are the flood plains of recent alluvium. The flood plains are flat, and deeply covered by moderately coarse to fine soils. The left bank consists mostly of gently undulating terrace derived from old alluvium or deluvial materials. Hills are scattered with steep slopes. Northern and eastern perimeters of the Choluteca plain come into contact with mountains.

From the viewpoint of irrigation engineering, the Choluteca plain can be commanded by two irrigation systems which can be separated from each other or combined together. One will command an area of 22,400 gross ha approximately conforming with the flood plain including the right bank, a sugar estate of 400 gross ha near Marcovia and the lower part of the left bank. The other will cover an area of 13,900 gross ha in the left bank as shown in Fig. 2. Hereinafter, the former area is referred to as the Western Plain and the latter area is named the Eastern Plain.

4.2 Soils

The soils in the Choluteca plain originate from volcanic rock, ash and schale of sedimentary rock. They are rather coarse and often contain rock fragments or gravel to a certain extent. They show pH values of 6-8.

As the order in terms of soil taxonomy, the Inceptisols, Entisols Mollisols, Alfisols, Vertisols, Ultisols are recognized in the Choluteca plain. A soil map of Choluteca plain is shown in Plate 2.

The Inceptisols are the recent fluventic soils found at some places in the flood plain along the Choluteca river and its old river course. Their texture is loam to fine loam in surface soil and fine loam to silty clay or clay in subsoil. These soils have a cambic horizon with ochric epipedon. The groundwater table is generally deep. These soils are fertile and well drained. The present crops are sugar cane, cotton, maize and sorghum. The Inceptisols are suitable for all upland crops under irrigation without limitation. The limitation in rice cultivation is poor water retention.

The Entisols are also recent fluventic soils widely developing in the flood plain along the Choluteca river and its old river course. Their texture is sandy loam to silty loam in surface soil and fine loam to silty clay or clay in subsoil. The pedogenetic horizon is indistinct. The groundwater is generally deep. These soils are fertile and well drained. The present crops are sugar cane, cotton, maize and sorghum. The Entisols are suitable for all upland crops under irrigation without limitation. The limitation in rice cultivation is poor water retention.

The Mollisols are the recent alluvial deposits but a little older than the Inceptisols and Entisols, developing in a wider range of the flood plain. The texture is fine sandy loam to loam in surface soil and loamy to loamy clay in subsoil. These soils have a cambic horizon with mollic epipedon. Some of Mollisols have the seasonal influence of groundwater table in the deep profile. The Mollisols are fertile to moderately fertile and moderately to imperfectly drained. The present crops are sugar cane, cotton, maize and sorghum.

The Mollisols are suitable for all upland crops under irrigation requiring drainage to a certain extent. There is no limitation for rice culture.

The Alfisols develop over the greater part of the terrace on the left bank and in the hills and mountains in the northern margin of the Choluteca plain. The Alfisols in the left bank terrace are sandy loam in surface soil and silty clay to clay in subsoil. They have an ochric or mollic epipedon in the surface and an argillic horizon in subsoil. They are stony to very stony. The groundwater is moderate to seasonally shallow. These soils are moderately fertile to infertile and imperfectly drained. Present crops are pasture and maize. These soils are suitable for the upland crop and rice except for the soils containing much gravel or shallow soils. Upland farming under irrigation needs certain drainage. The Alfisols in hills and mountains are fragmental loam containg abundant gravel. They have argillic horizon. These soils are infertile. The present crop is pasture. They are suitable only for pasture. Shallow soil and relatively steep slopes are the limitations for upland crops.

The Vertisols are the terrace deposits mostly developed in the Ola area (northwestern corner of the Choluteca plain). The texture is clay to fine clay in surface soil and fine clay in subsoil. These soils show the galgai micro-relief in surface and have parallel-piped structure in subsoil. The subosils generally are abundant in small calcium concretions and faint mottlings. The groundwater table is moderate to seasonally shallow. These soils are fertile but imperfectly drained. The present crops are pasture, maize and sorghum. The Vertisols are suitable for upland crop except for sugar cane and vegetables, under irrigation requiring drainage to a certain extent. Rice culture on these soils has no limitation.

The Ultisols are terrace deposits developing on the left bank only to a minor extent. The texture is sandy clay in both surface soil and subsoil. An albic horizon is underlain by an argillic horizon. The groundwater table is moderate to seasonally shallow. These soils are fertile to moderately fertile and imperfectly drained. The present crops are pasture and maize. These soils are suitable for upland crops except sugar cane and vegetables, under irrigation requiring drainage to certain extents.

There is no limitation in rice culture.

The distribution of soils in the Choluteca plain is as summarized in Table 18. This table shows that the Mollisols are predominant in the Western plain, while the Alfisols prevail in Eastern plain.

4.3 Land Capability Classes

Land capability was evaluated in accordance with USBR standard:

Class I: Highly suitable for irrigation farming without significant limiation.

Class II: Moderately suitable for irrigation farming with moderate limitation due to coarse texture, rather steep slope or soil depth limited by gravel layer or impermeable subsoil.

Class III: Rather suitable for irrigation farming with limitations due to shallow soil, gravelly soils, stony soils, rather steep slope or low fertility.

Class IV: Marginally or conditionally suitable for irrigation farming with rather serious limitations due to very shallow soil, steep slope, small land size or imperfect drainability.

Class VI: Unsuitable for irrigation farming with serious limitations.

A land capability map of Choluteca plain is shown in Plate 3.

The lands of 32,260 ha or 89 % of the Choluteca plain fall in Class I: highly suitable to Class III: rather suitable for the irrigation farming as shown in Table 19. In the Western Plain, 13,490 ha or 60 % of lands are classified in Class I: highly suitable to Class II: moderately suitable for irrigation farming, while in the Eastern Plain 9,650 ha or 69 % of lands are classified in Class III; rather suitable for irrigation farming.

4.4 Land Use and Present Farming Practices

The land of 30,920 ha or 85 % of the Choluteca plain is utilized for the agricultural purpose. Among them, 9,410 ha are cultivated for crop production and the remaining 21,510 ha are used for stock farming, as

shown in Table 20. The major crops are sugar cane, cotton, maize, sorghum, sesame, rice, melon and water melon mainly grown in the Western plain as shown in Plate 4.

Semi-mechanized farming is common; the land preparation is done by tractor except for some peasant farms but other operations are not mechanized in general. According to the farm survey, semi-mechanized farm is 100 % for sugar cane, 100 % for cotton, 80 % for maize, 40 % for sorghum and 100 % for sesame. The farming practice and estimated yield are described for each crop hereunder.

Sugar cane is grown in 5,070 ha mostly on the right bank. The varieties grown are NCO310, B43-62 and CP3437, NCO310 being the majority. The growth period is 13-16 months for the plant cane and 11-12 months for the ratoon cane. Ratoon is generally 4-6 times, depending on the soil condition. The cropping calendar is as follows:

	Plant Cane	Ratoon Cane
Land preparation, planting (or ratooning) and basic fertilization	Aug. - Oct.	Nov. - May
Top dressing	Oct. - Dec. or May - Jul.	Dec. - Jun.
Earthing	Oct. - Dec.	---
Weeding	May - Nov.	May - Nov.
Harvesting	Nov. - Jan.	Nov. - May

Fertilizers applied are 250 kg of compound fertilizer and 90 kg of urea per ha for both the plant and ratoon canes but in newly reclaimed fields 140 kg of urea only is applied. Insect and disease damage is slight but rat damage is often reported. Some of the estate farms are irrigated but inadequately. The yield is estimated to be 78.6 tons/ha in the estate farm and 70 tons/ha in the outgrowers' farm.

Cotton is grown in 890 ha of collective farms mainly on the right bank. The major varieties are Stonville 213 and Conal-S. The cropping calendar is as follows:

Land preparation	May - Jun.
Seeding & basic fertilization	Jul. - Aug.
Reseeding & thinning	Aug. - Sep.
Herbicide application	Jul. - Aug.
Top - dressing	Aug. - Oct.
Weeding	Aug. - Oct.
Insecticide application	Sep. - Mar.
Harvest	Jan. - Mar.

The basic fertilizers are 130-150 kg of compound fertilizer (12:24:12 or 15:15:15) and 10-20 kg of urea per ha. Urea of 60-70 kg/ha is applied in top-dressing. Herbicides and insecticides are applied by aircraft. Cotton are grown under rainfed conditions. The yield is estimated to be 2 tons/ha. The produced lint is good in quality and mostly exported to Japan.

Maize is grown in 1,960 ha mainly on the right bank. The major varieties are HPB, Sintatico Tuxpeno and V. Criollas. The growing term is 110-120 days for HPB and Sintatico Tuxpeno and 80-90 days for V. Criollas. Single cropping is prevailing but dual cropping during the wet season with V. Criollas is practiced in some places. The cropping calendar is as shown below:

	Single Cropping	Dual Cropping	
		1st Crop	2nd Crop
Land preparation	May - Jun.	Mar. - Apr.	Jul. - Aug.
Seeding & fertilization	Jun. - Jul.	Apr. - May	Aug. - Sep.
Insecticide application	Jul. - Sep.	May - Jun.	Sep. - Oct.
Tilling & weeding	Jul. - Oct.	May - Jul.	Sep. - Oct.
Harvest	Sep. - Nov.	Jul. - Aug.	Nov. - Dec.

Few fertilizers are used. Furadan of 25 kg/ha or Malathion 1:1000 dilution are applied for insect control. The yield is estimated to be 2.0 tons/ha in the semi-mechanized farm and 1.6 tons/ha in the traditional farm.

Sorghum is grown only in 200 ha mainly at the foot of hills where soils are unsuitable for maize. The varieties are CENTA S-1 for human consumption and ICA NATAIMA, E59 Dekalb, E57 Dekalb and 8417 Pioneer for

animal consumption. Sorghum is sown in May and harvested in August. The yield is estimated to be 2.0 tons/ha in the semi-mechanized farm and 1.6 tons/ha in the traditional farm.

Sesame is grown in 140 ha. The varieties are Venezuela 44, Instituto 70, Tardias, etc. Sesame is sown in August and harvested in November-December. The yield is estimated to be 1.3 ton/ha.

Rice has been introduced only in recent years. There is a large-scale commercial farm of 160 ha on the left bank. The farm is fully mechanized but irrigation from the Sampile river is insufficient for the dry season cropping. Other rice farms of 360 ha are inadequately irrigated by tube well, being scattered on the left bank area. Varieties are SICA 4 of good yield but susceptible to blast, being introduced from Colombia, Blue bonnet-50 of native variety and IR 100 intorduced from Nicaragua, susceptible to blast. The cropping calendar is as follows:

Land preparation	Apr. - May
Seeding & basic fertilization	Jun. - Jul.
Top-dressing	Jul. - Sep.
Harvest	Oct. - Dec.

Rice is directly sown on the dry field by drill seeding machine. Basic fertilizers are 130-150 kg of compound fertilizer (12:24:12 or 15:15:15) and 10-20 kg of urea per ha. Urea of 60-70 kg are top-dressed. Herbicides and insecticides are periodically applied. The harvest is done by a grain combine or by hand. The yield is estimated to be 2.5 paddy tons/ha.

Melon is grown in 280 ha of light soils. The varieties are SJ45 and TAm Den. SJ45 of 60-65 days in the growth period is sown in November-December and harvested in January-February. TAm Den of 70-75 days growth period is sown in November-December and harvested in February-March. Fertilizers applied are 190 kg of compound fertilizer (20:20:0), 130 kg of potassium nitrate and 90 kg of urea per ha. Yield varies from 4 to 7 tons/ha depending on the seeding time. About 60 % of melon in the Choluteca plain is exported to USA.

Water melon is grown in 220 ha of light soils. The main variety is Charlston Grey of 80 days growth period. Water melon is sown in May-August and harvested in October-December. The yield is estimated to be 6-10 tons/ha.

Stock farming is carried out in 21,510 ha including pasture of 12,990 ha and forest of 8,520 ha under rainfed conditions. About 70 % of pasture or 9,100 ha is cultivated with improved pasture grasses such as Estrella Africana, Elephant grass, Guinea grass and Jaragua grass and the remaining 30 % is natural grass pasture. The cattle population is estimated to be 43,000-44,000 or 2 heads/ha including calves. Cattle is emaciated and the mortality is high at 15 %, though they are mostly transmitted to the places where grasses are available in the dry season. Holstein and Guernsey for milk, Cebuinas, a hybrid of Cebuinas and native meat cattle for meat, and Brown Zwiss for dual purpose are fed. The yield is estimated to be 190 liters of milk and 128 kg of meat per ha.

4.5 Present Agricultural Production

The present agricultural production in the Choluteca plain is estimated to be 384,100 tons of sugar cane, 1,800 tons of seed cotton, 3,700 tons of maize, 300 tons of sorghum, 200 tons of sesame, 1,600 tons of paddy rice, 56,000 cases or 1,500 tons of melon, 1,800 tons of water melon, 4,100 kl of milk and 2,800 tons of meat as shown in Table 21.

4.6 Farm Economy

A farm survey resulted in a present farm budget of a typical farm by holding size group as shown in Table 22.

Individual small holders largely depend for their income on maize cultivation, while the crops in cooperative farms are rather diversified. The farm management in large farms is generally specialized for sugar cane, cotton, maize, rice and cattle grazing.

The large holders hire laborers from individual small holders and landless farmers.

Farming expenses account for 40-60 % of the production income. Living expenses is about $1,200 for the cooperative farmers and individual small holders, but it is over $5,000 for middle and large holders. The small holders are on the subsistense level while large holders raise a good profit from farming.

4.7 Agro-industries

There are two sugar factories in the Choluteca plain. One is Azucarera Choluteca S.A. (ACHSA) which has been operated since 1968 being located at the center of the right bank area and the other is Azucarera Central S.A. (ACENSA) which is going to be commissioned by the end of 1977 at 1.5 km to the south of ACHSA.

Table 23 shows the operation record of ACHSA. From this table, it is estimated that the net operation days are 150 days, the milling capacity is 1,300 tons day and the sugar recovery is 10 % under ordinary operation conditions. Note that the factory was operated rather long and sugar recovery dropped in 1976/77 because certain cane was supplied from ACENSA. ACHSA has estates of 1,540 ha and outgrowers' farms of 1,160 ha surrounding the factory. The estate farms are irrigated from the Choluteca river and tube well but insufficiently.

ACENSA capacity of 4,500 tons/day has the estates of 3,240 ha partly irrigated and has made contracts with farmers of 510 ha for cane supply. The farms of ACENSA are scattered around the farms of ACHSA except that 1,120 ha is located in Santa Rosa 40 km to the northeast. An estate farm of 130 ha at Palo Seco is not operated because of the saline water from tube well.

A cotton ginnery belonging to the Cooperativa Agropecuaria Algodonera del Sur Limitada is located at San Lorenzo. Its processing capacity of 90 tons/day is going to increase to 250 tons/day by January 1978. The seed oil factory adjacent to the ginnery belongs to the same cooperative. Its processing capacity of 20,000 tons/year has the problem of shortage of material.

There are two slaughter houses, IGHSA and CARNILAND, in Choluteca. The daily capacity is 300 head for IGHSA and 100 head for CARNILAND. Cattle slaughtened at IGHSA were 25,000 head in 1976.

4.8 Existing Irrigation

ACHSA has a pumping station commanding 990 ha on the right bank. ACENSA constructed two pumping stations, one commanding 420 ha on the right bank and the other commanding 360 ha on the left bank. These pumping stations take water from the Choluteca river. ACHSA's pump of 113.7 m^3/minute seems to be too small and it could irrigate only 850 ha. There are 6 irrigation establishments of small portable pumps depending on the Choluteca river. The total area is 260 ha (see Table 24). The crops are rice, maize, sorghum, beans and pasture. There is a rice estate of 160 ha at the eastern margin of the Choluteca plain. This farm takes water from the Sampile river which depletes in the dry season.

There are about 60 tube wells for irrigation mostly on the right bank. The total area is 2,225 ha. Among them 38 wells are for 1,410 ha of sugar cane estates of the sugar factories.

The existing surface and groundwater irrigation establishments are shown in Tables 24 and 25. Generally, the existing irrigation is only supplementary due to insufficient water or inadequate capacity of facilities. It seems that most of the irrigation establishments will be abandoned if more reliable water is made available.

An investigation by TAHAL Consulting Engineers Ltd., of Israel resulted in the fact that the ground-water resources in the Choluteca plain are scarce and saline within 7 km from the coast line. ACENSA estate of 130 ha at Palo Seco is not operated at present because the water from tube wells is saline. A private company failed to find groundwater for rice cultivation, though drilling was made in many places in the left bank area. The tube wells are used only for supplementary purposes because the yield is low. Some tube wells were abandoned due to difficulty of maintenance. There may be groundwater available to some extent, but its exploitation is regarded to be only an interim measure until firm water supply becomes abailable.

4.9 Population, Land Holding and Land Tenure

The Choluteca plain belongs to the Choluteca and Marcovia Municipios in the Choluteca Department. In lower subdivisions it includes 12 Aldeas or Caserios. The Choluteca plain had a population of 16,913 or 3,318 households in 1974 as shown in Table 26. It is estimated that the farmers' population was 14,300 or 2,810 households. About 78 % live in the Western Plain.

The number of households and farm areas in 1974 is shown according to land holding size in Table 27. The landless farmers are 1,728 households or 61.4 % and 989 households or 35.2 % are holders of less than 50 ha. Except for the sugar cane estates of 3,530 ha, 17,780 ha or 57.5 % of lands are held by 93 households or 3.4 %.

Regarding land tenure, the composition is 66 % of privately owned land, 12 % of national or communal land, 7 % of rented land and 15 % of other land.

4.10 Institutional Support

Extension service, research and seed multiplication are carried out by MRN. Resettlement and cooperative activities are organized by INA. Agricultural credits are extended by BNF.

The Choluteca Office of MRN has 16 extension offices each having an extensionist. The services are inadequate with limited staff and budget.

The experimental station of MRN at La Lujosa has a farm of 200 ha, 40 ha for seed multiplication and 120 ha for training. The station is responsible for research and seed multiplication of sorghum and sesame at a national level and rice and peanuts at a regional level. The station is divided into a Research Section and Production Section. The Research Section consists of 4 engineering agronomists, an agronomist and a field operation superintendent. The Production Section comprises an agronomist and an assistant agronomist who carry out the multiplication of improved varieties.

Implementation and operation of irrigation facilities are also the responsibility of MRN.

The Choluteca Office of INA has organized about 150 cooperatives or resettlement associations under the Agrarian Reform Law (Decreto-Ley No. 170). The cooperatives in the surveyed Choluteca plain are 21 in number. A cooperative of 18 members operate about 110 gross ha on average. The cooperative farms are generally well managed by machinery introduced but income is low due to water shortage.

The agricultural credits of BNF are the Refeccionario for procurement of house and machinery, Avio for procurement of agricultural input and livestock, and Hipotecario for the factory construction and land acquisition. The interest rate is 11 % but 10 % for the factory construction. A total of $3.75 x 10^6 was credited in relation with 9,170 gross ha in the Choluteca Department in 1976.

4.11 Resettlement Schemes

INA has implemented two major resettlement schemes in the Choluteca plain. They are the Monjaras-Buena Vista scheme and the Ola scheme.

The Monjaras-Buena Vista scheme was originally envisaged in 1958/59 to involve most areas bounded by the Choluteca river in the east and the Gulf of Fonseca in the south and west. By the end of 1976, 24 groups with 557 members were settled in a total area of 2,372 ha. INA intends to acquire a further 8,750 ha for resettlement under this scheme.

The Ola scheme was initiated in 1958 to distribute 9,240 ha to the north of the Monjaras-Buena Vista area, but little development has been achieved. INA is reformulating the scheme with an initial stage plan to distribute 3,700 ha to 740 families.

4.12 Agricultural Market

MRN supplies the seeds of maize, sorghum, beans, rice and some others. Sugar factories supply seed cane. Fertilizers and chemicals are obtained from tradesmen.

Sugar factories buy sugar cane at the contracted price which was $9.65/ton at the mill gate in 1976/77. Transportation between farm and factory is undertaken by a transportation company at a charge to the farmer depending on the distance.

Seed cotton produced in the Choluteca Plain is sold to the ginning factory of the Cooperativa Agropecuaria Algodonera del Sur Limitada. The ginnery gate price was $562/ton in 1976/77.

Grains such as maize, sorghum and rice are sold to middlemen or BNF which controls the grain prices by setting a minimum price every year.

5. OBJECTIVES AND OUTLINE OF THE PROJECT

5.1 Objectives of the Project

The objectives of the project are set by taking into account the immediate need for agricultural production as follows:

(1) Sugar cane supply to the existing sugar mills in the Choluteca plain

(2) Supply of increasing grain demand in the southern region; Choluteca and Valle Departments

(3) Vegetable and horticultural crop production to improve the diet and increase small holders' income

(4) Cotton production where possible for diversification of industrial crop and increase in farmers' income

(5) Irrigation where possible to the Monjaras-Buena Vista and Ola resettlement schemes

The target year of the project is 1985.

The two sugar factories of 5,800 tons/day in total capacity need 870,000 tons of sugar cane for the full operation in net 150 days. The present sugar production is estimated to be 454,000 tons including 384,000 tons in the Choluteca plain and 70,000 tons in Santa Rosa. It is necessary to increase sugar cane production in the Choluteca plain to about 800,000 tons.

The shortage in grain production in Honduras in 1985 is estimated to be 170,000 tons in 2.4. This serious shortage cannot be met by a single project. Grain production in the proposed project will meet the demand in the southern region. Census results showed that 1974 population was 193,300 in Choluteca Department and 91,900 in Valle Department. The growth rate is estimated to be 2 % for Choluteca Department and 1 % for Valle Department. With these figures the population in these two departments is estimated to grow to 343,000 by 1985. This population will need about 57,000 tons of grain, if the present demand level of 167 kg per capita is sustained. The grain production in the two departments

except the Choluteca plain is estimated to be 22,000 tons. Consequently, the grain production to be assigned to the project will be 35,000 tons.

The demand for vegetables and horticultural crops in the future may be regarded as unlimited, as the present production is quite limited. The introduction of these crops is based on the benefit to small holders.

With proper irrigation, most grain crops will allow cotton cultivation under a double cropping system. Cotton is introduced to the maximum extent because it is highly beneficial.

It is estimated that out of 3,700 ha of the Ola resettlement area, 3,000 ha can be irrigated if the Western Plain is irrigated, based on a study on the cadastrals. For the Manjaras-Buena Vista area, 1,900 ha of the envisaged area can be commanded by the Western Plain irrigation, but the soil conditions in the remaining 6,450 ha need further study.

5.2 Rationale of the Project

The sugar cane farm will be expanded to the extent that the sugar mills can be fully operated in any case. About 11,840 ha of sugar cane field will be needed in the Choluteca plain, if farming conditions are not seriously altered. This requirement could be met by converting mainly the pasture/forest land in the Western plain. The expansion of other crops can hardly be expected under the expanding pressure of sugar cane field if there is no improvement.

The project is envisaged to attain the objectives set in 5.1 by largely increasing the land productivity through year-round cultivation with irrigation and drainage facilities provided in part of the Choluteca plain.

The project area will be the Western Plain defined in 4.1. The Western Plain is much more suitable than the Eastern Plain for the following reasons. The Western Plain is dominated by the recent alluvial soils of high productivity, which have been cultivated for crop production for a long time. Sugar factories are located in the middle of the right bank. The majority of farmers in the Choluteca Plain live in the Western plain.

The Western Plain involves Monjaras-Buena Vista and Ola resettlement projects. The Western Plain is large enough to accommodate a net irrigable area of 16,000 ha which is necessary to attain the objectives placed.

The proposed project area (Western Plain) is among the few of those with productive soils. It will be entirely utilized for crop production and stock farming should be shifted from the project area to the hilly area.

There are three pumping stations of sugar cane estates in the Western Plain. The commanded areas of these pumps are included in the project area because the sugar cane production is the most important objective of the project and all the farms should be orderly operated. The pumps are short of water compared with their present capacity. They will be adequately utilized after some adjustment in the commanded areas when the river flow will be regulated by a proposed dam.

The construction of a storage dam will be the premise for the irrigation development in the Choluteca Plain. The annual flow in the Choluteca river is abundant, though the dry season flow is slight. A storage dam will make it possible to irrigate the Choluteca Plain all the year round by retaining flood in the wet season and releasing it in the dry season. This regulation of river flow will also enable further irrigation development in the middle reaches.

The storage dam is proposed primarily for the irrigation purpose. Thenceforth, a power generation is proposed as far as it is feasible.

5.3 Outline of the Project

The principal feature of the proposed project is shown in Tables 28 to 30. A more detailed outline will be described in subsequent paragraphs.

6. PROPOSED AGRICULTURE

6.1 Proposed Land Use

The land use in the project area is proposed as shown in Table 31.

The sugar cane field will be increased by 1,590 ha or in total 6,760 ha.

The land used for growing grain is 8,300 ha. Maize will be the majority. Sorghum and beans will also be grown to certain extents. There are heavy soils being classified in Class III in Ola (Vertisols) in the north and in the southern end (Mollisols and Alfisols) of the project area. They need special drainage measures for growing upland crop at high productivity but there is no limitation for rice cultivation. Therefore, 1,600 ha of heavy soil areas are apportioned to rice paddy.

Cotton will be cultivated under the double cropping system mainly with grain. The crop area will be 5,100 ha.

Vegetables, melon and water melon will be planted on the light soils (recent alluvial soils) along the Choluteca river. The extent will be about 10 % of the cultivated area.

Pasture, forest, bush and scrub scattered will be reclaimed for cropping but 140 ha of class IV soils will be pasture land.

The proposed cropping pattern is illustrated in Fig. 3. From this figure the crop area is calculated to be 24,300 ha or 1.52 in the multiple crop index.

6.2 Proposed Farming Practice

With irrigation made available by the project, farming practice will be improved in various aspects such as cropping calendar, crop varieties, fertilizer application, pest and disease control and mechanization. By these measures combined with proper management of water, high crop production will be sustained. The main points of standard farming practice are proposed as follows:

Sugar cane: NCO310 is the prevailing variety at present. It is tolerant to drought, vigorous in tillering and early maturing and it shows good yield in ratoon. This variety, however, presents unfavorable characteristics; much flowering, fine stalk and high fibre content, and higher yield of cane is hardly expectable under higher rate fertilizer application. The recommendable varieties are large stalk varieties such as B 34-62, CP 3437, Pinder and Q 51.

The proposed cropping calendar includes 10-month fallow, 14-month plant cane growing and four 12-month ratoon cane cultivation:

Description	Plant cane	Ratoon cane
Land preparation	Mid-Aug to Mid-Apr	
Planting/ratooning and basic fertilization	Mid-Sep to Mid-May	Mid-Nov to Mid-May
Herbicide application	Mid-Sep to Mid-May	
Top-dressing	Mid-Oct to Mid-Jul	Mid-Dec to Mid-Jun
Rodenticides application	Mid-Nov to Mid-Feb	Mid-Jan to Mid-Feb
Tilling & weeding	Mid-Oct to Mid-Jul	Mid-Dec to Mid-Jun
Harvest	Mid-Nov to Mid-May	Mid-Nov to Mid-May

Seed cane will be grown on a proper nursery field protected from insect damage. At present, a high rate of 10 tons/ha of seed cane is used for planting, to care for poor germination due to drought. This rate can be reduced to 6 tons/ha under irrigation.

The fertilizer application rate recommended is N 150 kg/ha: P_2O_5 50 kg/ha: K_2O 50 kg/ha as a standard. Herbicide will be 1.5 kg/ha of Atrazine (wettable) in each application. In view of severe rodent damage, application of 1-5 % in cereal bait of zinc phosphate is proposed with proper care of human and animal life.

Furrow irrigation at a rate of 7.1 mm/day with intervals of 10-15 days depending on soil condition is proposed. The field will be dried for 30 days before the harvest to obtain high sugar recovery.

Land preparation will be carried out by tractor. About a month after planting in the plant cane field or harvesting and cutting of stubble in

the ratoon cane field, the field will be levelled by a tractor. The earthing to cane root will also be carried out by tractor a month later. The work thereafter such as top-dressing, weeding and harvesting will be manual.

Proper harvest scheduling based on the measurement of Brix value is indispensable for high sugar recovery.

The yield of sugar cane is 90 tons/ha for the plant cane and 80 tons/ha for the ratoon cane, respectively, under present rainfed conditions. These high yields indicate quite suitable soil and climate conditions in the project area. It is expected that the cane yield under irrigation will be further increased.

The yield under the proposed farm management is estimated to be 150 tons/ha for the plant cane, and 140 tons/ha for the ratoon cane; a planting and four ratooning in a 6-year cycle including fallow will make up an average yield of 118.3 tons/ha.

Maize: In accordance with the recommendation by La Lujosa Experimental Station, the maize varieties will be Sintetico Texpeno, V. Criollas and Nicarillo as the free polination varieties, and HB 101, HB 105 and HA 502 as the hybrid varieties.

The recommended cropping calendar is as follows:

Land preparation	Mid-Jan to Mid-Apr
Seeding & basic fertilization	Mid-Feb to Mid-May
Herbicides application	Mid-Feb to Mid-May
Top-dressing	Mid-Mar to Mid-Jun
Tilling & weeding	Early-Apr to Mid-Jul
Insecticides application	Early-Apr to Mid-Jul
Harvest	Early-Jun to End-Aug

The standard fertilizer application rate will be N 50-100 kg/ha: P_2O_5 50 kg/ha: K_2O 0-50 kg/ha. Herbicide will be 1.5 kg/ha of Gesaprim 80 (wettable) in each application. Insecticides will be 1.5 lit/ha of Cytralene or Dipterex emulsion in each application and 3.5 kg/ha of Furadan dust.

Furrow irrigation at a rate of 5 mm/day with intervals of 7-14 days depending on soil condition is proposed.

The seed rate will be 16 kg/ha. Land preparation, seeding, fertilization and tilling will be carried out by tractor. Aircraft will be employed for the application of chemicals.

The yield under with-project conditions is estimated to be 4 ton/ha.

Sorghum: The recommendable varieties are CENTA S-1, SART and C-42-Y for human consumption, and ICA NATAIMA, E59 Dekalb, E-57 Dekalb, 8417 Pioneer for animal consumption.

The proposed cropping calendar is as follows:

Land preparation	Mid-Jan to Mid-Mar
Seeding & basic fertilization	Mid-Feb to Mid-Apr
Herbicides application	Mid-Feb to Mid-Apr
Top-dressing	Mid-Mar to Mid-May
Tilling & weeding	Early Apr to End-May
Insecticides application	Early Apr to Mid-Jun
Harvest	Early Jun to End-Jul

The standard rate of seed, fertilizer, chemicals and other farming practices will be the same as those for maize.

The yield under with-project condition is estimated to be 4 tons/ha.

Beans: Lima beans are grown to a limited extent in the project area. Not only for food production but also for soil conservation, it is proposed to increase the cultivation of beans.

The recommended varieties of lima beans are Desarrural V.B., Desarrural V.R. and Porillo.

The following cropping calendar is proposed:

Land preparation	Mid-Jan to Mid-Mar
Seeding & fertilization	Mid-Feb to Mid-Apr
Tilling & weeding	Mid-Mar to Mid-May
Insecticides application	Mid-Mar to End-May
Harvest	Early Jun to End-Jul

The standard application rate of fertilizer will be N 50 kg/ha: P_2O_5 30 kg/ha: K_2O 0-30 kg/ha. Malathion emulsion of 2 lit/ha will be applied.

Furrow irrigation at a rate of 5.4 mm/day is proposed. The irrigation interval will be 7-14 days.

Seeding will be done by machine at a rate of 45 kg/ha. Seeds will be inoculated with leguminous bacteria for high yield. Land preparation, fertilization, insecticides application will also be carried out by machinery.

Apart from lima beans, the cultivation of soybean is promising for oil production and soil conservation. In this connection, research on soybean cultivation in the project area is recommended.

The yield under with-project condition is estimated to be 2 tons/ha.

Sesame: The recommendable varieties are Instituto 70 and De Sarrural C 10 as early maturing branchless varieties, Venezuela 44 as late maturing branchless variety, and Tardias as late maturing branch variety.

The cropping calendar will be:

Land preparation	Early Sep to End-Oct
Seeding & basic fertilization	Early Oct to End-Nov
Herbicides application	Early Oct to End-Nov
Thinning	End-Oct to End-Dec
Top-dressing	Early Nov to End-Dec
Insecticides application	Early Nov to End-Feb
Harvest	Early Feb to End-Mar

The standard application rate of fertilizer will be N 30-50 kg/ha: P_2O_5 20 kg/ha: K_2O 10 kg/ha. Herbicides will be 2 kg/ha of Herban 80 (wettable) each application. Insecticide will be 1.0 lit/ha of Dipterex emulsion each application.

Land preparation will be carried out by tractor. Strip seeding in spaces of 60 cm will be carried out manually with the seeding rate of 3 kg/ha. The thinning 15 - 20 days after germination will be done at the hill spaces of 15 cm.

The yield under with-project condition is estimated to be 1.5 tons/ha.

Rice: The recommended variety is CICA 6 of good germination, resistance to blast, vigorous growth and high yield. It showed yield of 7.2 paddy tons/ha under irrigation at La Lujosa Experimental Station in 1976.

Two-cropping with the following calendar is proposed:

Description	Wet season rice	Dry season rice
Land preparation	Early Aug to End-Sep	Mid-Jan to Mid-Mar
Seeding & basic fertilization	Early Sep to End-Oct	Mid-Feb to Mid-Apr
Herbicide application	Early Sep to End-Oct	Mid-Feb to Mid-Apr
Top-dressing	Early Oct to End-Nov	Mid-Mar to Mid-May
Weeding	Early Sep to End-Dec	Mid-Mar to Mid-Jun
Fungicides & insecticides application	Early Sep to End-Jan	Mid-Mar to Mid-Jul
Harvest	Mid-Jan to Mid-Mar	Early Jul to End-Aug

The fertilizer application rate will be N 100 kg/ha: P_2O_5 50 kg/ha: K_2O 0-25 kg/ha. Herbicides will be 5-10 lit/ha of Propanil emulsion or 3 lit/ha of 2.4 D emulsion in each application. Spraying of 30 kg/ha of Kasumin dust for the blast control and 2 lit/ha of Malathion emulsion for the control of stem borer and aphis will be applied.

Seeds will be directly sown on the dry field by seeding machine at a rate of 70-80 kg/ha.

The field will be flooded from 20-25 days after seeding to a month before harvest except drying-up for 20 days before the young panicle formation. Deep flooding between the young panicle formation and heading is important.

Machinery will be employed for land preparation, seeding, basic fertilization and harvesting. Agro-chemicals will be applied by aircraft in the collective farms.

The yield in each harvest is estimated to be 5 tons/ha in paddy or 3 tons/ha in polished rice.

Cotton: Presently recommended varieties are Stonville 213 and Conal - 5. The Cooperativa Agropecuaria Algodonera del Sur Limitada is going to introduce improved varieties from abroad.

The recommended cropping calendar is as follows:

Land preparation	Early Jun to End-Jul
Seeding & basic fertilization	Early Jul to End-Aug
Thinning	Early Aug to End-Sep
Top-dressing	Early Aug to End-Sep
Tilling & weeding	Early Aug to End-Nov
Insecticides application	Mid-Jul to Mid-Dec
Harvest	Mid-Jan to Mid-Mar

The standard fertilizer application rate is N 100 kg/ha: P_2O_5 50 kg/ha: K_2O 25 kg/ha. Herbicide will be 1.5 kg/ha of planevin (wettable). For the insect control, 2 lit/ha of Malathion emulsion and 1.0 kg/ha of Orthene will be applied 10 to 20 times.

The seed rate will be 25 kg/ha. The irrigation rate will be 6.8 mm/day. The irrigation interval will be 7-14 days.

Land preparation, seeding, fertilization, tilling will be carried out by tractor. Chemicals will be applied by aircraft.

The yield under with-project condition is estimated to increase to 3 tons/ha.

The farming practice for melon and water melon under irrigation will not be much different from the present.

6.3 Resettlement

The project irrigation system will cover 4,900 ha of INA resettlement areas; 3,000 ha for the Ola scheme and 1,900 ha for the Monjaras-Buena Vista scheme. In the Ola scheme area 1,500 ha is already settled. If these areas are distributed into 5 ha farms, 300 existing settlers and 680 new settlers can be benefited.

6.4 Labor Requirement

The annual labor requirement under with-project condition is estimated to be 1,351,000 man-days including 1,298,000 man-days of normal farm labor and 53,000 man-days of machine operators. Note that the drivers for the transportation of sugar cane are not included in this estimate, because cane transport will be carried out by a transportation company on a contract basis.

The monthly distribution of labor requirement is shown in Table 32. The peak monthly labor requirement is estimated to be 240,000 man-days or 8,600 persons occuring in January, in which the harvest of sugar cane and cotton is at full swing.

The farm labor force in the project area in 1974 is estimated to be 5,200 persons, assuming 2.5 persons in each of 2,070 farm households. This will increase to 6,400 persons in 1985, if the population growth rate of 2 % is sustained. As some settlers will come from outside, the labor force will be more than 7,000 persons. The labor requirement can be met by the labor force within the project area for 10 months between March and December, but a certain number of laborers will be needed from outside of the project area for the 2 months of January and February.

The labor requirement from outside of the project area is estimated to be 27,000 man-days in total and 1,000 persons at the peak time of January. There are about 100,000 farm labor force in the Choluteca Department. They are mostly engaged in maize cultivation the harvest of which is carried out in September to November. December to April is

the off-peak season. The required laborers for the project will be hired from the vicinity of the project area. Under more developed conditions surrounding the project area in the future, a mechanized harvest will be introduced for the saving of labor force.

6.5 Machinery Requirement

Deep plowing and speedy operation of each step of cultivation are desirable for sustaining high yield of crops. The farm size is relatively large and crops can be arranged seasonally under the project. Taking into account these conditions, certain mechanizations will be introduced.

Land preparation such as plowing, harrowing and didging will be carried out by tractor with a proper attachment.

Seeding and basic fertilization will be carried out by tractor with seed machine and fertilizer distributer attached. Tilling will be carried out by tractor-drawn cultivator. Chemicals will be applied mostly by aircraft on a contract basis. Harvest will be carried out manually but by combine for rice.

There are 100 tractors with some attachment in the project area. Farming machinery additionally required for the proposed agriculture is estimated as shown in Table 33.

6.6 Fertilizer and Chemical Requirement

Based on the standard dose presented in 6.2, the annual requirement of fertilizers and agro-chemicals is estimated as shown in Table 34.

6.7 Prospective Increase in Agricultural Production

The increase in the agricultural production attributable to the project was estimated as the difference between the productions under with- and without-project conditions. The land use under without-project condition is assumed that the sugar cane field will increase by 6,800 ha encroaching on the pasture and forest while the other crop areas remain as they are, because it is by all means necessary to produce sugar cane

in sufficient quantity to meet the demand of the existing two sugar mills in the project area even under without-project condition.

The estimated increase in production is 17,600 tons of maize, 2,900 tons of sorghum, 1,600 tons of beans, 8,940 tons of rice, 13,800 tons of cotton, 1,000 tons of sesame, 1,200 tons of melon 3,100 tons of water melon and 16,000 tons of vegetables as shown in Table 35. Sugar cane will meet the factories' demand. Livestock products will be reduced by 800 kℓ of milk and 500 tons of meat, because the present area for livestock raising in the project area will be converted to crop production. This area, however, occupies only 8 % of 143,000 ha of the total pasture land in the Choluteca Department, and the livestock production in the Department will not be much affected.

7. PROPOSED PROJECT FACILITIES

7.1 Irrigation Water Requirement

The consumptive use of water by crop is the basis for estimates of irrigation water requirements. It was calculated as the product of the estimated potential evapotranspiration and seasonal consumptive use coefficient. The potential evapotranspiration was calculated according to recent meteorological data available at the Choluteca meteorological station. The values of potential evapotranspiration obtained by the modified Blaney-Cliddle, modified Penman, Hargreaves and Christiansen-Hargreaves methods were compared with the A-pan evaporation data at Choluteca as shown in Table 36 and the values by the Christiansen-Hargreaves method was taken up, because they best conformed with the A-pan evaporation values in terms of the annual variation and annual total value. The seasonal crop consumptive use coefficients applied were those proposed by Hargreaves.(Ref. 10).

Rainfall on the crop land will turn partly to consumptive use, the remainder being lost as surface flow. Effective rainfall on upland was estimated by the USDA SCS method (Ref. 5). Table 37 shows the monthly rainfall record for 1967-1975 as the arithmetic mean of the values at the Choluteca meteorological station and ACHSA farm. According to this record the annual rainfall of 90 % probability of exceedance was estimated to be 1,452 mm. This value was distributed to each month in accordance with the average monthly rainfall distribution through the recorded period. The rainfall thus obtained is shown in the last column of Table 37 and it was used for the estimate of effective rainfall on the upland.

The effective rainfall on paddy was estimated by the daily water balance method based on the daily rainfall record in 1966-1975. The assumptions introduced are that 80 % of rainfall can be effective but rainfall less than 5 mm or excessive rainfall over 80 mm is ineffective. The percolation rate of 3 mm/day was assumed. The effective rainfall having 90 % of probability of exceedance was used for the estimate of irrigation water requirements.

The net irrigation water requirement was estimated by deducting the effective rainfall from consumptive use. Application of water to a farm plot involves a certain loss due to spillout in both upland and paddy, and deep percolation in upland. The application efficiency was estimated to be 65 %, taking into account soil conditions. The losses during conveyance of water are considered in the distribution efficiency which was assumed to be 85 % in the distribution canals and lower grade canals and 95 % in the concrete-lined main canals. Consequently, the irrigation efficiency was assumed to be 52.5 % (= 65 % x 85 % x 95 %).

Detailed calculation sheets of water requirements are compiled in ANNEX H.

Table 38 shows the irrigation diversion water requirement in the project area, and existing and potential irrigation areas in the middle reaches of the Choluteca river. The annual irrigation water requirement is estimated to be 334 x $10^6 m^3$ including 275 x $10^6 m^3$ in the project area and 59 x $10^6 m^3$ in the middle reaches. The peak water requirement is estimated to be 29.5 m^3/s including 24.2 m^3/s in the project area and 5.3 m^3/s in the middle reaches.

7.2 Dam and Reservoir

7.2.1 Selection of Damsite

A reservoir operation study was carried out to determine the storage capacity at the San Fernando damsite and Morolica II damsite. The monthly inflow was estimated from the runoff record at Hernando Lopez for the San Fernando damsite and Los Encuentros for the Morolica II damsite. The lake evaporation assumed is 1,065 mm/year for the San Fernando damsite and 1,762 mm/year for the Morolica II damsite. The storage capacity necessary to meet the irrigation water requirement in the project area and the middle reaches of the Choluteca river was calculated to be 210 x $10^6 m^3$ for both the damsites allowing a failure once in ten years.

IECO estimated the sedimentation at the San Fernando damsite to be 240,000 tons/year based on the observation in 1966 and determined the dead storage capacity to be 55 x $10^6 m^3$ for a 50-year life as described in ANNEX A. This estimate followed in this report. The dead storage capacity

at the Morolica II damsite was determined to be 160 x $10^6 m^3$ by the same procedure assuming the same sediment concentration as at the San Fernand damsite.

The probable maximum flood was estimated to be 5,280 m^3/s in the peak discharge and 511 x $10^6 m^3$ in volume for the San Fernando damsite, 6,390 m^3/s in the peak discharge and 1,035 x $10^6 m^3$ in Volume for the Morolica II damsite by transposition of Hurricane Fifi to the damsites.

Both the concrete dam and the rockfill dam are possible at the San Fernando damsite as will be explained later while a rockfill dam only is conceivable in the rather wide valley of the Morolica II damsite. The required dam height is 88 m for the concrete gravity dam at San Fernando and 79 m for the rockfill dam at Morolica II. It is estimated that the investment cost is \$36.9 x 10^6 for the San Fernando dam and \$55.1 x 10^6 for the Morolica II dam, respectively, as shown in Table 39. The San Fernando damsite is definitely better than the Morolica II damsite for the envisaged water storage because of the large difference in investment cost.

7.2.2 Dam Type

It is estimated that the foundation rock at the San Fernando damsite has low shearing strength. The construction of a concrete arch dam cannot be recommended for the time being, though it might be justified by detailed exploration in the future. A concrete gravity dam with a wide base will be feasible assuming a shearing strength of 10 kg/cm^2 in the foundation rock. Less care will be required for the foundation strength if a rockfill dam is constructed.

A comparative study in ANNEX G resulted in a little higher investment cost of the rockfill dam as compared with the concrete gravity dam, because core material is unobtainable locally and working space is limited. In this report the San Fernando dam is designed as a concrete gravity dam. A rockfill dam will be an alternative to be studied in the future.

7.2.3 Optimization of Dam Height

The San Fernando dam will retain water in the wet season and release it in the dry season for irrigation purposes. Certain power can be generated by utilizing the released water in the dry season at the cascade of the dam. Power generation in the wet season will also be possible if more active storage capacity is provided in the reservoir by a higher dam. A higher dam may gain more potential because it develops higher water head and larger perennial flow. However, there is a limit to the dam height at which the incremental power benefit can justify the incremental cost.

A study was made to find out the optimum dam height by introducing power generation. It was assumed that power would be generated by fully utilizing water which would be released for irrigation purposes in the dry season while a 5-hour peak power generation would be carried out in the wet season. With this assumption the proposed power station will be a base load station in the dry season and peak load station in the wet season. Power benefit was estimated assuming an alternative steam power plant of $500/kW of investment cost. The fuel cost was assumed to be 75.4 US mills/lit. The alternative thermal plant had an installed capacity equal to the dependable peak power which was assumed to be the peaking capacity of the hydroplant with 90 % dependability. It generated the same energy as hydropower. The annual cost was capitalized for 50 years assuming a discount rate of 14 %.

The results of optimization study are summarized in Table 40. The optimum dam height is estimated to be 93.5 m at which the benefit less cost becomes the maximum.

7.2.4 Description of Proposed Dam and Reservoir

The proposed plan and sections of dam and power station are shown in Plates 8, 9, 10 and 11.

The San Fernando damsite has a catchment area of 1,665 km^2. The annual inflow is 425 x $10^6 m^3$. The sound rock surface in the river bed is located at EL. 735.5 m.

The proposed reservoir will provide an active storage capacity of 330 x $10^6 m^3$ between the low water surface (LWS) at EL. 794.5 m and high water surface (HWS) at EL. 823. 5 m. The dead storage capacity below LWS will be 55 x $10^6 m^3$. A surcharge of 200 x $10^6 m^3$ will be provided between HWS and the flood water surface (FWS) at EL. 828.5 to prepare for the probable maximum flood. The flooded area by the reservoir will be 22 km^2 at FWS.

The dam will be a concrete gravity dam of 93.5 m in height, 217.0 m in the crest length and 310,000 m^3 in volume. The dam crest will be at EL. 829.0 m. The upstream face of the dam will be 1:0.15 with a fillet of 1:0.8 in slope below EL. 775.0. The downstream slope will be 1:0.8. A crest road of 8 m in width will be provided. A coefficient of horizontal seismic acceleration was assumed to be 0.12.

The peak discharge of 5,280 m^3/s of probable maximum flood will be reduced to 2,470 m^3/s by being routed in the surcharge space of the reservoir. A spillway capable of this reduced discharge will be located at the center of the dam in the direction of river course. Three sets of radial gates with a height of 8 m and width of 10 m will be installed on the ogee crest at EL. 816.5. The gate will be operated by a motor-driven hoist which will be installed on the top of concrete pier. The upper portion of spillway chute will be the downstream face of dam guided by concrete side walls. The lower part of chute will be an upturned flip bucket on the roof of power station. A plunge pool of 70 m in length will be provided below the flip bucket, being protected by concrete on the bottom and side valley walls. A concrete sub-dam at the end of plunge pool will be constructed. It will be a ogee dam of 40 m in length and 7.5 m in height. Figure 4 shows the proposed reservoir operation and power generation assuming the inflow from August 1954 to April 1976.

An intake for the river outlet and turbine will be a steel lined bellmouth at the upstream face of dam. The bottom elevation will be EL. 789 m. A fixed trash rack and a roller gate of 5.0 m in height and 5.0 m in diameter will be embedded in the dam between the intake and power station. Maximum discharge in the penstock will be 27.1 m^3/s.

The power station will be located at the toe of dam. It will be a concrete structure of 25 m in width, 22 m in length and 23 m in height. A generator with a vertical shaft Francis turbine of 62 m in the rated head and 27.1 m^3/s in the maximum discharge will be installed. The power station capacity will be 14 MW. The annual energy output is estimated to be 58.35 GWh. The transformer and switching equipment will also be located in the power station. A Howel-Bunger valve with a butterfly valve will be installed in the power station to release water in the case of power station stoppage. The tailbay will be located between the power station and plunge pool. Two sets of roller gates with a height of 2.5 m and width of 3.0 m will be installed at the end of draft tube. The normal tailwater level is estimated to be EL. 745.0 m for the maximum discharge of 27.1 m^3/s. A single circuit 60 kV transmission line will be constructed in 25 km between the power station and the Tegucigalpa substation to transmit power to the ENEE interconnection system.

A concrete lined diversion tunnel of 3.6 m in diameter will be excavated for a length of 310 m in the right bank. The upstream cofferdam of 7.5 m in height and downstream cofferdam of 5.5 m in height will be random embankment structures. The diversion system can carry 40 m^3/s of discharge so that the foundation excavation, consolidation grouting and concreting during 6 months of dry period can be safely carried out.

Part of the new highway between Tegucigala and Talanga and the highway of Olancho will be flooded by the proposed reservoir. These highways will be relocated as shown in Plate 9; the former will take a detour along the western edge of the reservoir and the latter will pass the crest road of proposed dam. The length of relocated road is estimated to be 8 km for the former and 10 km for the latter.

7.3 Intake Facilities

7.3.1 Alternative Weir Sites

Las Bases and El Papalon sites were investigated as the alternative intake weir sites for the irrigation in the Choluteca plain.

Las Bases Weir Site is located in the flood plain of fine silty deposit of EL. 50 m about 5 km upstream of Choluteca. The river channel is 100 m in width with the river bed at EL. 37 m. There are hills of rhyolitic tuff on the left bank. The flood plain on the right bank is 850 m wide connecting 5-10 m higher terrace land. The river deposit consists of gravels including boulders of 50 cm in diameter. Boring No.B-1 on the flood plain near the river brink of the right bank reached massive and moderately hard tuff breccia at a depth of 13.7 m. If a weir is constructed at this site, an irrigation system can cover the whole Choluteca plain of 36,300 ha by gravity. If this site is selected for the irrigation of the project area (Western Plain only), it will be less economical than the El Papalon site, because a long head reach will be necessary. This site should be considered for possible irrigation in the Eastern Plain in the future.

El Papalon Weir Site is located about 9 km downstream of Choluteca City. The river channel is 100 m in width and 5-7 m in depth with a bottom at EL. 20.5 m. The left bank is an extensive alluvial plain of EL. 28 m. There is an isolated hill of andesite and rhyolite of 20 m in height at the river brink on the left bank. The right bank flat of 150 m in width connects with hills of Tertiary tuff and rhyolite. It consists of volcanic breccia with dacitic andesite near the river bank. The river deposit consists of sand and gravel of andesite, dacite, rhyolite and tuffs with the maximum size of 15 cm. Boring No. P-1 in the river bed reached weathered andesite at 9.4 m in depth and solid andesite at 13.1 m in depth. This site is suitable for a concrete weir. El Papalon site is selected as the intake weir site because it is closer to the proposed project area than Las Bases site.

7.3.2 Description of Proposed Intake Facilities

The intake weir will be constructed at El Papalon to maintain the pondage water surface at EL. 23.8 m at which the proposed irrigation system can take water of 20.45 m^3/s. A proposed design of intake weir is shown in Plate 17.

El Papalon weir site has a catchment area of 7,100 km^2. The annual inflow is estimated to be 1,400 x $10^6 m^3$. An estimated 100-year flood of 2,600 m^3/s is taken as the design flood.

The intake weir will be a concrete structure on the floating foundation being 140 m in crest length, 4.8 m in height and 15,000 cubic meters in volume as shown in Plate 17. The weir will have an ogee crest at EL. 23.8 m in a length of 125 m. Two lines of steel sheet pipe cutoff walls will be provided between the weir bottom and bed rock. A 15 m wide concrete apron blanket with dental sills and cutoff will be provided downstream of the weir. Concrete cross block floor will continue for 25.0 m further downstream. The upstream concrete blanket will be 10 m in width. A scoring sluice will be provided, of 3 sluice gates of 3.5 m in height and 3.0 m in width with a motor-driven hoist at the right end of the weir. The bottom of the scoring sluice will be at EL. 20.5 m. A scoring trough of 12.0 m in width and 45.0 m in length with concrete bottom and concrete side walls upstream of the sluice will maintain the low water channel at the right side of pondage. The pondage water surface will be at EL. 28.4 m for the design flood discharge, the sluice gate being at the fully opened position. The pondage will be normally confined within the existing river channel but the water surface may raise higher than the river bank when flood occurs. Therefore low levees will be constructed at a total length of 17 km on both banks of the river upstream of the weir.

The intake will be located on the right bank just upstream of the scoring sluice section of the weir facing to the scoring trough. The inlet bay is a rectangular concrete open channel with the bottom at EL. 22.3 which is 1.8 m above the bottom of scoring trough. The width of the inlet bay will narrow from 29 m at the inlet to 12 m at the downstream end. Two sets of trash rack will be installed at the inlet. Three sets of roller gates of 2.0 m in height and 3.0 m in width will be installed for the closure at the end of the inlet bay. A desilting basin of 90 m in length and 20 m in width with partition walls inside will be constructed following to the inlet. The desilting basin will be annexed with a sand flush channel having two sets of sluice gates. Two sets of stoplogs will be installed at the end of the desilting basin, where the main canal will begin.

7.4 Irrigation Canal System

The main canal system will consist of the upper main canal, left main canal and right main canal. The upper main canal will stretch for 12.8 km on the right bank approximately along the Choluteca river between the intake and the distribution point of the existing and old Choluteca river channels. The main canal will be distributed into the left and right main canals at the bifurcation structure located at the end of the upper main canal. The left main canal will lie at a distance of 8.6 km between the bifurcation structure and about 2 km to the north of El Palenque along the existing river channel. The right main canal will run 4.9 km toward the west on the right bank of the old river course.

The left main canal will distribute to the left branch canal 1 and right branch canal 1. The left branch canal 1 will cross the existing Choluteca river near the end of the left main canal by an inverted siphon and it will run along the Choluteca river to El Palenque, and thereafter it takes a southeasterly course. The left branch canal 1 will branch out from the left branch canal 1-a near El Palenque to the southwest. The length will be 9.0 km for the left branch canal 1 and 2.5 km for the left branch canal 1-a. The right branch canal will traverse for 7.0km along the Choluteca river.

The right main canal will have three branch canals. The branch canal 2 will start at the middle of right main canal. It will take a northerly course and will turn to the west. Nearing ACENSA mill, it will again turn to the south and then reaches to Monjaras on the left bank of the old river channel. The length of the right branch canal 2 will be 11.8 km. The right branch canal 3 takes a general course to the south approximately along the right bank of the old river course for 9.0 km between the end of the right branch canal and about 1 km to the north of Monjaras. The right main canal 4 will be projected to the west from the end of the right main canal and will bend to the south. The length of the right branch canal 4 will be 7.2 km.

The secondary canals branching off the main and branch canals are 25 in number and 84.5km in total length.

The proposed layout of the main, branch and secondary canals is as shown in Plate 14. The lengths of the canals are summarized in Table 41.

The main canal will be 10-cm thick concrete lined trapezoidal open channel with the side slopes of 1:1.5 having an appropriate freeboard for the design discharge. The design flow velocity will be 0.5 m/s at the minimum and 1.5 m/s at the maximum, respectively. The branch canal will be 60-cm thick earth lined trapezoidal open channels with the side slopes 1:1.5 or 1:1.0. The design flow velocity will be 0.2 m/s at the minimum and 0.6 m/s at the maximum. The typical cross sections of canals are shown in Plate 16.

The secondary canal R-O-1 will lie on rather high elevations near the intake weir compared with the upper main canal. A booster pump is proposed to lift water from the upper main canal to the secondary canal R-O-1. The booster pump station will be installed with 5 sets of centrifugal pumps of 5 m in the total water head and 44 m^3 minutes in capacity, one set being stand-by. A 16-hour daily operation is proposed.

The bifurcation structure will be located at the end of the upper main canal to distribute water to the left and right main canals as shown in Plate 18. Its upstream portion will be an enlarged rectangular concrete open channel where the flow velocity will be substantially reduced. A check gate will be located at the middle of the bifurcation structure with four sets of roller gates of 2.5 m in height and 2.5 m in width, each two of them controlling the discharge either in the left or right main canal. A rectangular concrete open channel partitioned by a concrete wall downstream of the check gate will be a stilling pool followed by parshall flume where flow is divided to the left and right main canal being measured by the parshall flumes.

An inverted siphon as shown in Plate 19 will be constructed across the Choluteca river at the beginning of the left branch canal 1. It will consist of 2 m x 2 m concrete box barrels with a trash rack installed at the inlet. The barrels will be embedded below the ground at a length of 85 m.

The canal-related structures such as turnouts, cross regulators, drops, culverts, bridges, spillways and measuring devices are listed in Table 42.

ACHSA pump of 113.7 m^3/min. in capacity located at 1.7 km to the east of Los Mangles, ACENSA pump of 87.2 m^3/min in capacity located at 4 km to the south-southeast of ACENSA mill and ACENSA pump of 79.6 m^3/min in capacity near Marcovia are presently short of water from the Choluteca river. With the storage supplement by the proposed San Fernando dam ACHSA pump can irrigate 850 ha to the northeast of ACHSA mill and ACENSA pump can supply to 420 ha to the south of ACENSA mill and another ACENSA pump will irrigate 360 ha on the left bank. These areas totalling 1,630 ha will be included in the project after adjustment of the commanding areas of pumps.

7.5 Drainage System

The river channel of Choluteca is rather deep and low natural levees develop on the banks. The inundation by the Choluteca river is not a major problem except in some locations. The slopes are slow and the drainage system is sparse in the project area. Intensive rain floods rather extensive depressions. When heavy rainfall occurs, the old river course carries certain discharges and lagoons retain water.

A surface drainage system is proposed to avoid excessive moisture in soils by flooding. A daily rainfall of 148 mm having 10 % of probability of exceedance was assumed according to data at the Choluteca meteorological station. The rainfall excess was assumed to be 70 % of the daily rainfall. The drainage requirement of 6 lit/s/ha was determined for the drainage in two days.

The main drain canals will be the existing distributaries and old river course being partly deepened or enlarged to be capable of the design drainage discharge. They are the right main drain canals 1 to 9, 3a, 7a, and the left main drain canals 7, 7b and 14 to 20.

The collector drain canals will be the tributaries of main drain canals. They will be natural tributary channels being partly improved or trapezoidal earth canals newly excavated.

The layout of the main and collector drain canal system is shown in Plate 14. The typical cross section of drainage canals are shown in Plate 16. The length of canals will be as summarized in Table 43.

The structures related to the drainage canal system are listed in Table 42.

7.6 Road System

An asphalt paved highway passes the center of the project area from the north to the south. Its northern end joins the Pan-American highway at about 8 km to the west of Choluteca and its southern end is Cedeno on the coast of Gulf of Fonseca. ACHSA and ACENSA mills are located beside this road. Some gravel-metaled and unpaved roads branch off the road. This road will be the mainstay of the transportation under the project.

The main farm roads will be constructed along the main and branch canals. They will be gravel-metaled road of 6 m in effective width. A short-cut including a submerging bridge across the Choluteca river will also be constructed between the existing highway and El Palenque for access between the right and left bank of the Choluteca river. The total length of the main farm road will be 57.0 km.

The secondary farm roads will be constructed along the secondary canal. They will be unpaved road of 3.4 m in effective width. The total length will be 64.5 km.

The layout of farm road system is shown in Plate 14 and typical cross section of proposed farm roads are shown in Plate 16.

7.7 On-farm Facilities

The typical farm size is proposed to be 600 m x 200 m according to the results of soil physical measurement and consideration on the effective machinery operation.

Two typical layouts of on-farm facilities are presented in Plate 20. One will constitute a 1.2 km x 1.2 km block of 12 farm plots. the longer side of farm plot contacting with a main or secondary canal and road.

Tertiary canals and roads will be constructed along the shorter side of farm plot. Farm ditches and field drains will project from the tertiary canal along each farm plot. A collector drain will be constructed across the middle of the block parallel to the tertiary canal. The collector drain will connect with the main or secondary drain canal. As the standard for a block, the tertiary road, tertiary canal and collector drain will be 1.2 km each in length. The total length of farm ditch and field drain will be 7.2 km each. Twelve division boxes will be provided. Another layout will include 12 farm plots constituting a 0.6 km x 2.4 km block. The longer side of the farm plot is adjacent to the main or secondary canal and road and the shorter boundary is a tertiary road with tertiary canal and collector drain. Farm plots are separated by farm ditch and field drain. As the standard for each block, the length of tertiary road, tertiary canal and collector drain will be 2.4 km each, and the total length of farm ditch and drain ditch will be 7.2 km each. Twelve division boxes will be provided.

The total length of tertiary roads, tertiary canals, collector drains, farm ditches and drain ditches and number of turnouts is estimated as shown in Table 44.

8. CONSTRUCTION SCHEDULE AND COST ESTIMATE

8.1 Construction Schedule

A construction schedule of the project is proposed as shown in Fig. 5, with an assumption that the foreign loan necessary for the construction will be committed by June 1978.

An international consulting engineers' firm will be appointed for the detailed survey, tender design, assistance for tender and contract, and construction supervision in collaboration with local supervisory staff.

The dam, power station, metalwork, generating equipment, transmission line, substation, intake weir, irrigation canals, drainage canals and farm roads will be constructed on the international contract basis, and the construction of access road, buildings and quarters, relocation of highway, reclamation and on-farm construction will be executed by local contractors. Table 45 shows an example list of contracts for the construction. Some of them may be combined together and some may be divided further.

Regarding the construction of dam and power station, the topographic survey, detailed geological exploration and tender design will be started as soon as the consultant is appointed in 1978. A local contractor will construct the access road and a major part of quarters and buildings prior to the mobilization of the civil contractor. The tender and contract for the civil work will be completed and the civil contractor will move to the site by the end of 1979. 1980 will be devoted to the construction of a diversion tunnel, setting of construction facilities and excavation of dam foundations. The river diversion, river bed excavation will be carried out at the end of 1980. The concreting of dam and foundation treatment will be carried out in 21 months in 1981/1982. The walls and roof of the power house will be completed before August 1981 when flood may spill over the dam and power house. The diversion tunnel will be closed in May 1982 so that the reservoir will be filled by October 1982. Test operation on dam and power station will be carried out in November and

December. The metalworks, generating equipment, transmission lines and substation will be installed and the highway will be relocated along with the above-mentioned timing. The dam and power station will be operational from the beginning of 1983.

The buildings and communication system in the Choluteca plain will be constructed early for use during construction.

The contract for the construction of El Papalon intake weir will be made in 1979. The contractor will establish a quarry and aggregate plant in 1980. These will produce the coarse aggregate necessary for all the concrete work in the Choluteca plain. El Papalon weir will be constructed by a two-stage diversion method. The right half including scoring sluice will be constructed in 1981 dry season and the left half will be completed in 1982. The cofferdam will be a double-line steel sheet pile wall with earth-fill.

The irrigation area of 16,000 net ha will be divided into 3 parts: Division 1 (3,300 ha) in the northern part, Division 2 (9,100 ha) in the central and southern part on the right bank and Division 3 (3,600 ha) on the left bank for the construction purpose. The construction of irrigation canals, farm roads, drainage canals and related structures will be carried out in parallel with the reclamation and on-farm construction in each division. The construction work will be completed at the beginning of 1982 for Division 2, at the end of 1982 for Division 1 and at the end of 1983 for Division 3.

Major materials, labor and construction equipment required for the construction of the project facilities are estimated and given in Tables 46, 47 and 48, respectively.

8.2 Investment Cost

The investment cost of the project comprises the direct construction cost, engineering and administraction cost, and compensation cost. In estimating the investment cost, all costs were estimated at 1977 price levels. A physical contingency of 10% and price contingency assuming an annual price rise of 5% were then added.

The direct construction cost was estimated on the unit price basis assuming that the construction will be executed by international and local contractors as explained in 8.1 and the import tax of materials and equipment will be exempted.

The investment costs were broken down into foreign and local currency components with an assumption that locally available resources were utilized to the maximum extent.

The detailed breakdown of the investment cost and the basic costs at 1977 price levels as the basis of unit prices are compiled in ANNEX 1.

The total investment cost is estimated to be $\$88.02 \times 10^6$ consisting of the direct construction cost of San Fernando dam and power station of $\$33.18 \times 10^6$, direct construction cost of irrigation, drainage and road system in the Choluteca Western Plain of $\$23.12 \times 10^6$, cost of engineering and administration of $\$9 \times 10^6$, compensation cost of $\$0.82 \times 10^6$, physical contingency of $\$6.61 \times 10^6$ and price contingency of $\$15.29 \times 10^6$. It is broken down into the foreign currency component of $\$56.44 \times 10^6$ and local currency component of $\$31.58 \times 10^6$.

The investment disbursement schedule is shown in Table 49 for the total cost, Table 50 for the foreign currency component and Table 51 for the local currency component.

8.3 Replacement Cost

Some parts of the proposed project facilities will periodically be replaced. They will be metalworks, generating equipment, transmission line and substation equipment. The economic life is different by item but it is estimated to be 25 years on an average. The replacement cost being deducted by 10% of salvage value is estimated to be $\$7.18 \times 10^6$ as shown in Table 52.

8.4 Operation and Maintenance Cost

The operation and maintenance cost (O&M cost) is estimated to be $\$1.45 \times 10^6$ as shown in Table 53.

9. ORGANIZATION AND MANAGEMENT

9.1 Organization and Management During Construction

During the construction period, the executing body of the proejct will be the MRN, and the cooperating bodies will be the INA and the ENEE.

The MRN will undertake the budget request, budget management, and the tender and contract administration concerning the implementation of the project. It will also be the end user of the foreign loan. The MRN will appoint a Project Manager who will be responsible for these activities. A foreign consulting firm will be employed by the MRN to assist the activities of the Project Manager.

The San Fernando Construction Office and the Choluteca Construction Office will be established under the Project Manager. The functions of each office will be land acquisition, approval of construction methods, approval of construction schedules, preparation of revised design, proposal of contract amendments, progress check surveys, check of quality control, approval of progress payments, progress payment to the contractors, and issuance of completion certificates. The organization of the two Construction Offices will be as shown in Fig. 6 and the number of the staff are estimated as shown in Table 54.

The INA Choluteca Office will undertake the land readjustment in the project area in accordance with Decreto-Ley No. 170, and also in the qualification of settlers, establishment of cooperatives and construction of tractor stations.

The ENEE will make an agreement with the MRN pertaining the pricing and operation rule of the San Fernando power station and will assist the MRN in construction of the power station, transmission line and substation under a unified standard, and in the operation of the power station.

9.2 Organization and Management for O & M

The project facilities will be state properties being managed by the MRN. The Construction Offices will be turned over to the San Fernando Dam Management Office and the Choluteca Water Management Office upon completion of the construction phase of the project.

The San Fernando Dam Management Office will undertake the operation and maintenance of the reservoir, dam and supervise the power station operation. The organization of the San Fernando Dam Management Office will be as shown in Fig. 7 and the number of the staff are estimated as shown in Table 55.

The Choluteca Water Management Office will undertake the operation and maintenance of irrigation, drainage and road systems of the project, including measurement of macro and micro-climates, soil moisture and distributed discharge. The Choluteca Water Management Office will be also responsible for the operation and maintenance of equipment which will be procured before the operation is commenced. The organization of Choluteca Water Management Office will be as shown in Fig. 8 and the number of the staff are estimated as shown in Table 56.

The MRN Choluteca Office and La Lujosa Experimental Station will be strengthened in the extension service, seed multiplication and training. The staff required for the adequate operation of the project will be 10 extensionnists, 4 agronomists and 3 trainers.

The INA will organize the farmers into cooperatives. It is estimated that the membership will be more than 1,500 after the completion of the project. The lowest unit of the cooperative will be established by location and crop zone, so that each unit will be rather specialized and easy to work jointly with large machinery. The cooperative units will be synthesized into a single cooperative federation covering the whole project area. Branch Offices of the federation being annexed with tractor stations will be established at 5 places.

The functions of the cooperative federation will be the distribution of certified seeds by the MRN to the cooperative members, procurement of fertilizers and chemicals, payment of water charge, and marketing of products.

The BNF will provide credit services for the procurement of farming machinery, procurement of agricultural input, and sharing of the project investment cost by farmers.

10. ECONOMIC ANALYSIS

10.1 Economic and Financial Prices

The prices of goods and services in a region is affected by various factors such as the imbalance in supply and demand, taxes, subsidies, import and export barriers, etc. The prices in the economic analysis are the approximations which would appear under a balanced economy. In this connection it has usually been recommended to estimate the economic price based on the international market price. This criterion is followed in this report.

The economic prices of internationally traded goods were estimated according to a projection to 1985 at 1977 constant price levels which is widely used by international financing agencies. The economic prices of goods traded locally only were estimated as the annual average local prices in 1977. The financial prices were all assumed to be average local prices in 1977. The economic and financial prices were estimated as shown in Table 57 for the agricultural products and Table 58 for the agricultural inputs. The details of the estimate are compiled in ANNEX J. The farm labor cost of $2/man-day was used for both the economic and financial analysis.

10.2 Project Irrigation Benefit

The net value of agricultural production was estimated for each crop under with- and without-project conditions as shown in Table 59 to 63. It is the gross income less the production cost which includes seeds, fertilizers, chemicals, labor, machinery charge, transportation and other cost but excludes taxes, water charges, repayment, and living expenses.

The above-mentioned net value was estimated for unit crop ha. The net production value for the whole crop areas is calculated to be $13.95 x 10^6 under with-project condition and $4.68 x 10^6 under without-project conditions, resulting in incremental benefits of $9.28 x 10^6 as shown in Table 64.

The San Fernando dam will be operational and Divisions 1 and 2 totalling 12,400 ha will be ready for cropping at the beginning of 1983 and the remaining Division 3 of 3,600 ha will be completed by the end of 1983. It will take a certain time to reach the full benefit after the commencement of irrigation farming. It is therefore assumed that the benefit will build up to 40% in 1983, 60% in 1984, 80% in 1985 and 100% in 1986 onward, for Divisions 1 and 2, and with a one-year lag for Division 3.

10.3 Power Benefit

The San Fernando power station of 14 MW will produce 58.4 GWh of energy annually, starting operation from 1983.

The power benefit was estimated as the cost of equivalent thermal power plant. It consists of the investment cost of 8.02×10^6 in 1982, annual cost of 1.35×10^6 and replacement cost of 7.27×10^6 in interval of 25 years as described in ANNEX F.

10.4 Production Forgone in the Reservoir Area

San Fernando reservoir will flood an area of 2,200 ha. The present production in the area cannot be continued after the completion of dam, though it is small. The production forgone in the reservoir area is estimated to be 0.11×10^6 as shown in Table 65. This is taken into account as a negative effect of the project.

10.5 Associated Benefit

The irrigation development of 1,680 net ha listed in Table 15 will be made possible in the middle reaches of the Choluteca river by the construction of San Fernando dam. The benefit accrual from these projects is regarded as the benefit associated with the project. It is estimated to be 1.20×10^6 as shown in Table 66.

Another associated benefit will be expected in the existing irrigation areas depending on the Choluteca main stream. Regulated river flow by the reservoir will avoid occasional river depletion which is

inevitable if natural flow only is depended upon. This type of associated benefit will be enjoyed in 1,470 ha of areas in the middle reaches (Table 14 except MRN Oropoli which depends on a tributary). This benefit is not included in economic analysis because it is small relative to the other benefit.

It is assumed that the associated benefit will accrue from 1983 and reach to the full value of $\$1.20 \times 10^6$ in 4 years.

10.6 Economic Benefit Stream

The benefits described above are summarized in an economic benefit stream as shown in Table 67.

10.7 Economic Project Cost

The economic project cost was estimated at 1977 price levels. It consists of the investment cost, replacement cost and O&M cost. The financial costs estimated in 8 include the transfer payment such as direct and indirect taxes and the profits of local companies. The transfer payment was estimated to be 10% of the direct construction cost, replacement cost and O&M cost, 2% of engineering and administration cost, and 100% of compensation cost. The economic costs of the project were derived by deducting the transfer payment from the financial costs.

The estimated economic investment cost is $\$65.44 \times 10^6$ as shown in Table 68. The other economic costs are $\$6.47 \times 10^6$ for the replacement and $\$1.31 \times 10^6$ for O&M.

10.8 Economic Associated Facilities Cost

The irrigation facilities in the middle reaches are assumed to be constructed in 1982. They are the facilities associated with the project. Their economic investment cost, replacement cost and O&M cost are estimated as shown in Table 69.

10.9 Economic Cost Stream

Table 70 shows an economic cost stream of the project and associated facilities.

10.10 Economic Internal Rate of Return

The economic internal rate of return (EIRR) of the project is estimated to be 12.2% based on the benefit and cost streams in Tables 67 and 70, with an evaluation period of 50 years starting in 1978.

The project will serve the project's irrigation of 16,000 ha, project's power generation of 14 MW and associated irrigation of 1,680 ha. The values of EIRR were calculated by purposes according to the following assumptions. Let us imagine that a dam is constructed only for irrigation purposes. The cost of this dam is divided into the project's irrigation and associated irrigation in the proportion of irrigable area. The cost difference between the proposed dam and power station and the imaginery irrigation dam was regarded as the project's power generation cost. The calculated values of EIRR are shown in Table 71.

A sensitivity test of EIRR was made for the following cases:

Case B: Benefit is 10% less than expected
Case C: Cost is 20% larger than expected
Case D: Accrual of benefit is delayed by one year than expected
Case E: Combination of Cases B and C
Case F: Combination of Cases B and D
Case G: Combination of Cases C and D
Case H: Combination of Cases B, C and D

The results of calculation are as shown in Table 72 and Fig. 9.

Judging from the values of EIRR, the proposed project is economically justifiable.

10.11 Unquantified Benefits

In the calculation of economic internal rate of returns, only irrigation and power benefits are taken into account. The feasibility and the importance of the project will further be supported by such several unquantified benefits as described below.

(1) Tegucigalpa, capital city of Honduras with a population of about 300,000, will be in short of city water supply in the near future, and no additional water sources have been identified so far. The reservoir to be created by the proposed San Fernando dam will be a possible water source to supply Tegucigalpa by means of a pumping and aqueduct system.

(2) The San Fernando dam will regulate the flow of the Choluteca river and alleviate an inundation due to severe floods in the downstream areas to a certain extent.

(3) There is a possibility to utilize the San Fernando reservoir for fish farming.

(4) The San Fernando dam and reservoir will offer a possibility of tourism development because it is located at about 20 km north of Tegucigalpa.

(5) The dependable river flow resulting from the operation of the San Fernando dam will avoid the drought damage which must have been a problem in the existing irrigation establishments of 1,650 ha in the middle reaches of the Choluteca river.

(6) The northern coastal plain of Honduras is comparatively developed with a development center in the Sula plain. By the implementation of the project, it is expected that another development center will be formed in the southern coastal plain. The new development center in the Choluteca plain is located near from the new port at San Lorenzo, which will facilitate export of the agricultural products under the project.

(7) The economy of Honduras largely depends on export of bananas and coffee. The project will produce sugar and cotton for export, which diversifies exportable agricultural products. The

diversification will protect the national economy from unstable banana and coffee markets and contribute to the stable economic development of Honduras.

(8) Construction of the project facilities will create working opportunities to the people in the central and southern regions of Honduras. The operation and maintenance of the project will also create permanent working opportunities. Together with an improvement of infrastructures, the southern coastal plain will be developed not only in the agricultural sector but also in other economic sectors.

It is to be noted that the proposed project is economically feasible even when these unquantified benefits are not taken into account.

11. FINANCIAL ANALYSIS

11.1 Farmers' Capacity-to-pay

If the proposed irrigation project is implemented, some of the large farms will be distributed to the settlers from inside and outside of the project area. A study showed that the distribution of land holdings in the project area would be as shown in Table 73.

A typical farm budget was prepared by the type of land holding as shown in Table 74. The gross income was calculated according to the expected crop yield under with-project conditions and the financial price estimated in Table 57. Each item of the production cost was also estimated according to the financial price. The labor cost included only the hired labor cost. The net farm income was calculated as the difference between the gross income and production cost. The net farm income less living expenses is the capacity-to-pay, which is the maximum capacity to pay tax, water charge and investment cost of project facilities.

The total capacity-to-pay is estimated in Table 75 from the figures in Tables 73 and 74. It is $\$12.13 \times 10^6$ at the full development stage consisting of $\$11.11 \times 10^6$ in the project area of 16,000 net ha and $\$1.02 \times 10^6$ in the associated irrigation areas of 1,680 ha.

11.2 Financial Power Benefit

The energy of 58.4 GWh generated at the projects' power station will be sent to Tegucigalpa. Deducting 5% of transmission loss, the annual energy sold will be 55.4 GWh including 24.3 GWh of primary power and 31.1 GWh of secondary power.

Taking into account the present cost of ENEE's thermal power described in ANNEX F, the unit rate is assumed to be 35 US mills/kwh for the primary power and 19.5 US mills/kwh for the secondary power. In consequence the annual income from power generation is estimated to be $\$1.46 \times 10^6$.

11.3 Financial Rate of Return

The financial cost and benefit stream is presented in Table 76, with an assumption that the prices in both the cost and benefit will rise at an annual rate of 5% during 6 years from 1977 to 1983 (until the completion of the project) but includes no increase thereafter.

The cost stream comprises the investment cost and O&M cost estimated in 8 but escalated with the above-mentioned assumption.

The benefit stream consists of the farmers' capacity-to-pay in the project area and associated irrigation areas, and the income from the sales of power being estimated in 11.2. They are escalated under the above-mentioned assumption.

The financial rate of return for the evaluation period of 27 years until 2004 is calculated to be 11.8% based on the data in Table 76.

11.4 Financial Statement

An indicative financial statement was prepared assuming the following conditions:

(1) The local currency portion of current investment cost of the project and the whole investment cost of the associated facilities will be financed from the Government budget.

(2) The foreign currency portion of investment cost of $\$56.44 \times 10^6$ will be financed by a foreign loan at an interest rate of 5% with a repayment period of 27 years including a grace period of 7 years.

(3) Farmers will bear $\$50 \times 10^6$ out of the total investment cost of the project and associated facilities at the time of completion of construction. They will repay this amount at an interest rate of 10% with a repayment period of 20 years including a grace period of 2 years.

(4) The O&M cost for irrigation will be collected from the farmers in the project area and associated project areas as the water charge.

(5) The current surplus will enter in the government asset for the repayment of foreign loan, recovery of Government budget and replacement.

The financial statement is as shown in Table 77. The foreign loan will be paid off in 27 years and the expenditure from the government budget will be recovered within 20 years.

11.5 Farmers' Income

The water charge, farmers' share on capital and annual repayment on loan are converted to the 1977 price levels as shown in Table 78.

The current balance of farmers' income and expenditure under the project was examined assuming that both the water charge and capital share would be distributed in proportion to the net irrigable area as shown in Table 79. The net farm income in this table was taken from Table 75. Compared with the present farm budget in Table 22, the current balance of farmers' income and expenditure will be largely improved.

12. STAGE DEVELOPMENT

12.1 General Concept

The proposed size of the project was determined according to the production target by 1985, soil conditions and economic viability. Small scale irrigation development possibilities were also taken into account. The project can, however, be phased out into stages, if circumstances require. The first stage development of the project, if phased out, is described herein.

The general concept of the first stage development of the project includes the irrigation development of 12,400 ha corresponding to Divisions 1 and 2 and construction of the San Fernando dam at the minimum scale for the irrigation. The irrigation development in Division 3 of 3,600 ha, heightening of dam, power installation are all left for a future stage. The irrigation development in the middle reaches, except for 340 ha for sugar cane in San Juan de Flores area, are suspended in the first stage.

12.2 Outline of Project Facilities

The principal feature of the proposed project facilities for the first stage development is as shown in Table 80.

The San Fernando dam will be constructed at a height of 79.5 m with 3 set of spillway gate installed on the ogee crest at EL. 800.5 m. The river outlet will be installed across the dam. Its intake will be at EL. 777.5 m which will be confronted by no sedimatation problem for 20-30 years after the completion. The proposed design of the San Fernando dam for the first stage is shown in Plates 12 and 13. The dam will be heightened by 14 m and a power station will be built at a future stage. Part of the intake and penstock for the future power installation will be embedded in the first stage dam and the spillway gate will be competitively used at a future stage. Highway relocation is necessary.

The irrigation system will be provided for 12,400 net ha of Division 1 and 2 areas. All the facilities will be capable of irrigation and drainage, even after Division 3 will be completed in the future.

12.3 Agricultural Production

The sugar cane production in the first stage of development will be about 800,000 tons which will meet the demand. The production of other crops will be 20,600 tons of grain, 9,000 tons of cotton and 14,200 tons of other crops.

Compared with the future production in the first stage area under without-project conditions, the production increase will be 111,600 tons of sugar cane, 17,600 tons grain, 7,500 tons of cotton and 11,000 tons of other crops as shown in Table 81.

12.4 Cost Estimate

The investment cost of the first stage development is estimated to be $\$63.91 \times 10^6$ including $\$21.37 \times 10^6$ for San Fernando Dam construction, $\$19.68 \times 10^6$ for Choluteca plain irrigation system construction, $\$6.60 \times 10^6$ for engineering and administration, $\$0.62 \times 10^6$ for land compensation and $\$15.64 \times 10^6$ for contingency. The cost is broken down into the foreign currency portion of $\$38.89 \times 10^6$ and local currency portion of $\$25.02 \times 10^6$.

The investment disbursement schedule will be as shown in Table 82, 83 and 84.

The replacement cost of the first stage facilities is estimated to be $\$1.84 \times 10^6$ as shown in Table 85, and O&M cost is estimated to be $\$1.07 \times 10^6$ as shown in Table 86.

12.5 Economic Analysis

The net production value in the first stage area is estimated to be $\$10.45 \times 10^6$ under with-project conditions and $\$3.92 \times 10^6$ under without-project conditions as shown in Table 87. The project irrigation benefit

is therefore calculated to be $\$6.53 \times 10^6$. The production forgone in the reservoir area will be $\$0.09 \times 10^6$ as shown in Table 88. The associated irrigation benefit in San Juan de Flores A and B of 340 ha is estimated to be $\$0.21 \times 10^6$ as shown in Table 89. These estimates resulted in the benefit stream of the first stage development as shown in Table 90.

The disbursement schedule of economic investment cost for the first stage development is estimated as shown in Table 91. The economic replacement cost of $\$1.66 \times 10^6$ and O&M cost of $\$0.96 \times 10^3$ are derived from the financial costs in Tables 85 and 86 assuming the composition of transfer payment to be 10%. The associated facilities costs are estimated as shown in Table 92. These costs are summarized in the economic cost stream as shown in Table 93.

The economic internal rate of return (EIRR) is estimated to be 9.1% based on the figures in Tables 90 and 93. The results of the sensitivity test are shown in Table 94 and Fig. 10.

The estimated values of EIRR is low compared with those for the single stage development of the whole project, but they still justify the first stage development.

It is desirable to implement the whole project in a single step from the viewpoint of impact to the national agricultural production and economy. On the other hand, the stage development of the project has a smaller investment which may enable earlier financing of the project. Anyhow the project should be implemented in view of urgent needs. Choice between the single stage development and multiple stage development will depend on the financial climate for the time being.

13. PROPOSED FURTHER ENGINEERING WORK

13.1 General

As soon as the Government of Honduras decides to implement the project and obtains the funds required for the project implementation, it should select local consulting firms to carry out the engineering work for preparatory works, including the access road to the San Fernando damsite, and the permanent offices and quarters to be used during the construction stage of the project in both the San Fernando damsite and the Choluteca plain. At the same time, the Government should select a fully qualified international consulting firm for the detailed engineering and supervision of the main works.

The international consulting firm, when appointed, will bear full responsibility for the engineering of the project implementation, in cooperation with the counterpart personnel furnished by the Government and with local consulting firms.

13.2 Scope of Work

The engineering services to be rendered by the selected international consulting firm will be divided into two stages, which are, Stage I - Detailed Engineering, and Stage II - Construction Supervision.

The proposed scope of work for each stage is as follows:

I. Detailed Engineering Stage

1. Topographic Survey and Mapping for San Fernando Dam and Power Station.

   (1) Aerial photomapping at a scale of 1:5,000 covering the reservoir area, and the approximate alignment of relocated highways, access roads and transmission line route.

   (2) Topographic mapping with a scale of 1:1,000 covering temporary and permanent structure sites.

   (3) Profile and cross section survey with basic stakings of structure sites, including quarry sites, relocated highways, and access roads.

2. Topographic Survey and Mapping for Choluteca Plain Irrigation System.

   (1) Aerial photomapping at a scale of 1:5,000 and with 0.5 m contour intervals, covering the Western Plain (the Project Area) of the Choluteca Coastal Plain.

   (2) Topographic mapping at a scale of 1:1,000 and with contour intervals of 0.25 m, covering such structure sites as building yards, intake weir site, canals and major related structure sites, on-farm construction sites, etc.

3. Geological and Material Investigations for San Fernando Dam and Power Station

   (1) Temporary access road and access facilities to the riverbed at the damsite.

   (2) Test adit excavation at the damsite.

   (3) In-situ rock test to measure shearing strength and deformation modulus of dam foundation rocks utilizing the test adits.

   (4) Seismic exploration at the damsite and quarry sites.

   (5) Core drilling with water pressure test at the structure sites and quarry sites.

   (6) Blasting test at the damsite and quarry sites.

   (7) Grouting test at the damsite.

   (8) Concrete aggregate test.

   (9) Concrete trial mix and concrete test.

   (10) Selection and mapping of prospective borrow areas.

4. Material Investigation for Choluteca Plain Irrigation System

   (1) Additional geological and material investigations at the intake weir site.

   (2) Survey for construction materials especially for embankment earth material.

5. Soil Survey and Tests

   (1) Detailed soil survey covering Class III and IV area in the Project Area (about 7,700 ha).

   (2) Additional survey on soil-water characteristics, i.e., furrow intake rate tests and cylinder intake rate tests on each of the soil types.

6. Additional Meteorological and Hydrological Investigations as required.

7. Tender Design

   (1) Tender design for San Fernando Dam and Power Station including hydro-electrical equipment, hydro-mechanical equipment, power transmission lines, substation equipment and highway relocation.

   (2) Tender design for Choluteca Plain Irrigation System including El Papalon intake weir, irrigation and drainage system, farm road network and related structures.

8. Study on Implementation Method

   (1) Study and recommendation on a contracting method of project works.

   (2) Study and recommendation on a type of each contract.

9. Tender Documents

   (1) Preparation of tender documents for international tenders complete with:

Instruction to Tenderers
Contract Forms
Conditions of Contract
General Specifications
Technical Specifications
Bill of Quantities
Tender Drawings

(2) Assistance in technical matters in the preparation of tender documents for local tenders.

10. Cost Estimates

(1) Preparation of cost estimates for each international contract before opening of the tenders.

(2) Assistance in cost estimate for local contracts.

II. Supervision of Construction

1. Assistance in Tender Procedures

2. Evaluation of International Tenders

3. Assistance in Negociation and Conclusion of Contracts

4. Supervision of Construction under International Contracts

(1) Quality control
(2) Progress control
(3) Payment control
(4) Safety control

5. Preparation of Working Drawing as scheduled and Design Modification as required for International Contracts

6. Assistance in Construction Supervision and in Preparation of Working Drawings for Local Contracts

7. Operation Guidance

(1) Preparation of an operation and maintenance manual for the San Fernando Dam and Power Station

(2) Preparation of an operation and maintenance manual for the Choluteca Plain Irrigation System

8. Assistance in Establishing Meteorological Stations in the Project Area to determine Operation Systems of Irrigation Water and to study Physiology of Crops.

13.3 Counterpart Personnel Requirement during Detailed Engineering Stage

The following counterpart technical personnel will be required during detailed engineering stage.

I. San Fernando Dam and Power Station

Title	Total man-months
Coordinator	10.0
Highway Engineer*	2.0
Building Engineer*	2.0
Surveyor	9.0
Assistant Surveyor	9.0
Civil Engineer	10.0
Electical Engineer	2.0
Hydraulics Engineer	4.0

II. Choluteca Plain Irrigation System

Title	Total man-months
Chief Irrigation Engineer	16.0
Irrigation Engineer	48.0
Surveyor	50.0
Assistant Surveyor	50.0
Soil Mechanic Engineer	3.0
Structural Designer	14.0
Building Engineer*	4.0
Electrical Engineer*	6.0
Soil Specialist	3.5

* For preparatory work to be carried out by local contracts

13.4 Cost Estimates for Engineering Work

Costs for engineering work are estimated at 1977 price levels as follows:

	F.C.	L.C.
	(Unit:	US$ 1,000)
I. Detailed Engineering Stage		
I-A. San Fernando Dam and Power Station		
1. Topographic Surveys	100	30
2. Geological Investigations	1,050	100
3. Material Survey	20	10
4. Tender Designs	600	50
5. Tender Documents	150	8
6. Cost Estimates	30	2
Sub-total	1,950	200
I-B. Choluteca Plain Irrigation System		
1. Topographic Survey and Soil Surveys	200	100
2. Material Survey	10	10
3. Tender Designs	300	100
4. Tender Documents	150	8
5. Cost Estimates	30	2
Sub-total	690	220
II. Supervision Stage		
II-A. San Fernando Dam and Power Station		
1. Pre-construction Works	50	20
2. Construction Supervision	2,300	210
3. Working Drawings	600	50
4. Design Modifications	400	60
Sub-total	3,350	340

	F.C.	L.C.
	(Unit:	US$ 1,000)
II-B. Choluteca Plain Irrigation System		
1. Pre-construction Works	50	20
2. Construction Supervision	1,430	150
3. Working Drawings	300	30
4. Design Modifications	230	40
Sub-total	2,010	240
Total:	8,000	1,000

The above cost estimate for engineering and administration does not include the physical contingency of about 10 % nor the price contingencies of about 20 %. When these contingencies are taken into account, the actual engineering and administration cost will be in the order of $12 million, accounting for 13.6 % of the estimated total investment cost of $88 million.

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8. ANUARIO ESTADISTICO 1975, MINISTERIO DE ECONOMIA.

9. POBLACION Y VIVENDA POR DEPARTAMENTO Y MUNICIPIO - 1974, DIRECCION GENERAL DE ESTADISTICA Y CENSOS.

10. CONTRIBUCION AL PLAN DE EMERGENCIA NACIONAL PARA LA PRODUCCION DE ARROZ Y OTROS CULTIVOS BAJO RIEGO, FAO/PNUD, JUNIO 1976.

11. PRAXEDES MARTINES, LA INDUSTRIA DEL AZUCAR EN HONDURAS. JULIO 1975.

12. TRADE YEARBOOK. VOL. 25. 27 & 29. FAO.

Table 1 LIST OF PARTICIPANTS IN THE FIELD SURVEY

Advisory Committee, JICA:

Mr. J Ishizaka	Chief of the Committee Ministry of Agriculture and Forestry
Mr. H. Kikkawa	Irrigation Advisor Ministry of Agriculture and Forestry
Dr. S. Hirose	Agronomy Advisor Professor, Nihon University
Mr. H. Kambe	Project Economy Advisor Overseas Economic Cooperation Fund

Consultants (Nippon Koei Co., Ltd.):

Mr. I. Kuno	Team Leader
Mr. S. Nishioka	Geologist
Mr. K. Yonemori	Hydrologist
Mr. O. Takahashi	Civil Hydraulic Engineer
Mr. S. Nagatoshi	Irrigation Engineer
Mr. S. Ban	Irrigation Drainage
Mr. M. Shimamura	Soil-Agronomist
Mr. M. Kuramitsu	Agronomist
Mr. T. Murono	Agro-economist
Mr. H. Koizumi	Economist (Coordinator)

Counterparts of Ministry of Natural Resources:

Mr. H. E. Elvir	Director, Unidad de Recursos Hidricos
Mr. J. San Martin	Civil Engineer (Coordinator)
Mr. J. A. Alvarez	Civil Engineer
Mr. J. Lanza	Economist
Mr. F. Paz	Soil Engineer

Table 2 AREA AND POPULATION BY DEPARTMENT

Department	Area (km^2)	Census Population in 10^3	
		1961	1974
Atlantida	4,251	93	148
Colon	8,875	42	78
Comayagua	5,196	96	137
Copán	3,203	126	152
Cortes	3,954	200	370
Choluteca	4,211	149	193
El Paraiso	7,218	107	141
Francisco Morazan	7,946	285	453
Gracias a Dios	16,630	11	21
Intibuca	3,072	73	82
Islas de la Bahia	261	9	13
La Paz	2,331	60	66
Lempira	4,290	111	128
Ocotepeque	1,680	73	51
Olancho	24,351	111	151
Santa Barbara	5,115	147	186
Valle	1,565	81	92
Yoro	7,939	151	195
Total	112,088	1,885	2,657

Source: Ref. 8

Table 3 EXPENDITURE ON GNP AT CURRENT PRICE

Unit: 10^6

	1971	1972	1973	1974	1975	1976
1. Private consumption	551	584	649	744	807	882
2. General government consumption	87	94	100	120	139	164
3. Domestic fixed investment:						
-Private sector	92	95	112	134	152	175
- Public sector	36	29	43	66	77	91
4. Change in stocks	-3	2	7	60	-5	-30
5. Export of goods and services	211	229	282	327	340	419
6. Less: Import of goods and services	218	219	293	454	450	501
7. Error and omission	1	0	-1	0	-2	1
8. GDP in factor cost: 1 + 2 + 3 + 4 + 5 - 6 + 7	757	811	899	997	1,058	1,201
9. Net factor income from abroad	-23	-25	-30	-11	-27	-42
GNP: 8 + 9	734	789	869	986	1,031	1,159

Remarks: The values in 1973 and 1976 are preliminary.

Source: Refs. 6 and 7

Table 4 GROSS DOMESTIC PRODUCT BY INDUSTRIAL ORIGIN

(Unit: 10^6 at current factor cost)

Sector	1971	1972	1973	1974	1975	1976
1. Agriculture, silviculture, fishery and hunting	237	258	284	289	279	317
2. Mining	15	16	22	32	27	30
3. Manufacturing	99	109	123	140	159	182
4. Construction	34	35	39	48	54	64
5. Electricity, gas, water and sanitary service	10	11	13	14	18	20
6. Transportation and communication	44	47	50	62	69	78
7. Commerce	88	92	98	108	121	136
8. Banking, insurance and real estate	20	23	26	32	34	38
9. Ownership of dwellings	53	58	63	64	69	74
10. Public administration and defence	25	27	29	31	34	38
11. Service	60	62	66	78	85	96
12. GDP at factor cost: total 1 to 11	684	738	813	898	949	1,073
13. Net indirect taxes	66	77	89	100	110	127
14. GDP at market price: total 12 and 13	751	815	902	998	1,059	1,200

Remarks: The values for 1973 and 1976 are preliminary.

Source: Refs. 6 and 7

Table 5 LABOR FORCE BY EMPLOYMENT

	Total		Urban		Rural	
	(10^3)	(%)	(10^3)	(%)	(10^3)	(%)
1. Agriculture, forestry, livestock and fishery	461	61	35	14	426	84
2. Mining and quarrying	2	0	1	0	1	0
3. Manufacturing	84	11	50	20	34	7
4. Construction	24	3	17	7	7	1
5. Electricity, water supply and sanitary services	2	0	2	1	0	0
6. Commerce	59	8	47	19	12	2
7. Transportation, warehousing and communication	21	3	15	6	6	1
8. Services	93	12	75	29	18	4
9. Unclassified	16	2	11	4	5	1
Total	762	100	254	100	509	100

Source: Ref. 8

Table 6 BALANCE OF PAYMENT

Unit: 10^6

	1971	1972	1973	1974	1975	1976
1. Balance of goods and services						
1.1 Export	217	235	289	335	349	428
1.2 Import	246	251	330	474	487	552
Balance (1.1 - 1.2)	-29	-16	-41	-139	-138	-124
2. Transfers	7	7	7	33	18	13
3. Current account balance (1 + 2)	-22	-9	-34	-106	-120	-111
4. Capital account						
4.1 Long-term	39	31	36	80	136	115
4.2 Short-term	-9	-10	1	29	0	29
Total (4.1 + 4.2)	30	21	37	109	136	144
5. Error and omission	-2	0	1	-1	1	-1
6. Increase in reserve (3 + 4 + 5)	6	12	4	2	17	32

Remarks: The export and import values of goods are adjusted FOB values.

Source: Refs. 6 and 7

Table 7 VALUES OF EXPORTED COMMODITIES

Unit: 10^6

	1971	1972	1973	1974	1975	1976
Banana	96	91	94	80	62	98
Coffee	23	27	48	44	57	98
Tobacco	2	2	3	4	6	
Maize	1	1	0	0	-	
Beans	2	2	0	3	1	
Cotton	1	1	2	3	5	
Sugar	2	2	0	5	7	
Frozen meat	13	16	22	17	18	24
Shrimp and lobster	3	2	2	4	10	12
Lumber	19	27	39	41	39	38
Lead and zinc	6	7	7	17	20	
Silver	4	4	4	13	11	
Petroleum derivatives	3	3	1	15	12	
Cement	0	1	2	1	3	
Others	12	16	25	42	43	
Total	187	202	252	289	294	370

Remarks: The values in 1973 and 1976 are preliminary.

Source: Refs. 6 and 7

Table 8 VALUES OF IMPORTED COMMODITIES

Unit: 10^6

	1971	1972	1973	1974	1975	1976
Food products	16	17	22	31	45	37
Beverage and tobacco	1	1	1	1	1	2
Non-food crude materials	2	3	33	5	6	8
Fuel and lubricants	17	19	26	63	69	49
Vegetable and animal oil and butter	2	2	2	5	4	6
Chemical products	30	31	40	56	58	75
Manufactured goods classified by material	55	56	75	105	87	114
Machinery and material for transportation	56	51	76	102	107	127
Miscellaneous manufactured goods	13	13	16	19	22	25
Miscellaneous goods	1	1	1	3	1	1
Errors	1	-1	0	1	0	0
Total	194	193	262	391	400	414

Remarks: Figures for 1973 and 1976 are preliminary.

Source: Refs. 6 and 7

Table 9 CONSUMER PRICE INDEX

1966: 100

	1971	1972	1973	1974	1975	1976
1. Foods	114	119	126	147	161	167
2. Dwellings	106	109	117	131	141	149
3. Clothes	112	115	125	135	141	147
4. Welfare	115	116	116	118	132	138
5. Medical service	117	122	127	140	152	163
6. Beverage and tobacco	113	116	119	123	129	145
7. Miscellaneous	105	106	106	119	130	136
General index	111	115	121	136	147	155
Annual increase in %	2.1	3.6	5.7	12.5	8.1	5.1

Source: Ref. 7 and 8

Table 10 GROSS DOMESTIC PRODUCT IN AGRICULTURE, SILVICULTURE, FISHERY AND HUNTING SECTOR

(Unit: 10^6 at current factor cost)

Sub-sector	1970	1971	1972	1973
1. Agriculture				
1.1 Bananas & plantain	61.6	62.3	70.8	73.3
1.2 Cereales	26.0	28.9	29.2	31.6
1.3 Beans	8.0	8.7	8.4	7.4
1.4 Coffee	25.8	26.7	27.0	40.5
1.5 Sugar cane	5.0	5.9	7.0	6.5
1.6 Tobacco	3.3	2.6	2.7	3.2
1.7 Cotton	0.8	0.5	0.6	1.3
1.8 Others	10.7	12.3	13.5	14.2
Total:	141.2	147.9	159.2	178.0
2. Silviculture	31.1	32.6	36.4	40.4
3. Stock breeding	40.2	44.1	48.4	52.2
4. Aviculture	8.1	8.3	9.4	9.9
5. Others	2.7	3.9	4.3	3.2
Grand Total:	223.3	236.8	257.7	283.7

Remarks: The figures for 1973 are preliminary.

Source : Ref. 6

Table 11 MAJOR AGRICULTURAL OUTPUT

Unit: 10^3 tons

	Banana	Maize	Sorghum	Rice	Beans	Coffee	Cotton	Sugar	Meat
1966	920	334	53	6	43	36	11		20
1967	1180	316	48	3	50	29	10	45	23
1968	1280	335	44	5	57	40	8	49	26
1969	1350	353	46	4	63	31	8	52	29
1970	1280	339	48	4	55	40	3	54	30
1971	1440	274	47	8	39	36	2	58	38
1972	1550	282	34	6	35	42	2	64	39
1973	1210	336	39	10	32	47	4	60	42
1974	1220	343	39	11	32	42	5	74	35
1975	770	342	63	10	35	54	5	74	40

Remarks: Blank - No data available.

Source: Ref. 8

Table 12 EXISTING AND FUTURE SUGAR PRODUCTION CAPACITIES IN HONDURAS

Unit: 10^3 tons

Sugar Mill	1976	Future
Northern Region		
CAHSA	57	68
Azucarera Chumbagua	12	24
Azucarera Yojoa	-	25
Azucarera del Norte	-	39
Sub-total:	69	156
Southern Region		
Azucarera Choluteca	19	19
Azucarera Central	-	68
Azucarera Cantarranas	-	29
Sub-total:	19	116
Total:	88	272

Source: Ref. 11

Table 13 GRAIN SUPPLY

	Production /1 10^3 tons	Import /2 10^3 tons	Export /2 10^3 tons	Total Supply (1)+(2)-(3)	Population 10^6	Per Capita Supply (4)/(5) in kg
1966	436	9	62	383	2.15	178
1967	417	9	43	383	2.21	173
1968	441	9	68	382	2.27	168
1969	466	8	33	441	2.33	189
1970	446	9	24	431	2.39	180
1971	368	3	25	346	2.46	141
1972	357	4	19	342	2.52	136
1973	417	3	3	417	2.59	161
1974	425	1	6	420	2.66	158
1975	450	53	3	500	2.73	183

Source: /1 Ref. 8
/2 Ref. 12

Table 14 EXISTING IRRIGATION IN THE MIDDLE REACHES OF THE CHOLUTECA RIVER

No.	Name Location	Net ha	Main Crop	Remarks
San Juan de Flores Area				
1	MRN San Juan de Flores	1,140	Sugar cane	Under rehabilitation
Oropoli Area				
2	MRN Oropoli	180	Maize, sorgham	Tributary
Orocuina Area				
3	PRODAI Las Sabilas, Apacilagua	210	Rice, maize, sorghum, sesame	
4	Asent. Las Sabilas, Apacilagua	20	Rice, sesame	
5	Asent. Las Trinidad, Orocuina	17	Sorghum, sesame, water melon	
6	Asent. San Rafael, Las Bases	18 18	Sorghum, sesame, melon	
7	Pre-Coop. El Brasil, Choluteca	45	Rice, sorghum	
8	Asent. Los Limones, Limon de la Cerca	20	Rice, sorghum, sesame	
	Sub-total	330		
	Total	1,650		

Remarks: A sugar cane field of 110 net ha with irrigation facilities taking water from small tributary in San Juan de Flores area is excluded, because the facilities is not functioning due to serious water shortage. Water source should be shifted to the Choluteca main stream.

Source : Field survey

Table 15 IRRIGATION POSSIBILITIES IN THE MIDDLE REACHES OF THE CHOLUTECA RIVER

No.	Name/Location	Net ha	Main crop	Remarks
San Juan de Flores Area				
1	San Juan de Flores A	230	Sugar cane	
2	San Juan de Flores B	110	Sugar cane	Rehabilitation
	Sub-total	340		
Morolica Area				
3	Morolica C	210	Grain, vegetable	
4	Morolica D	90	Grain, vegetable	
	Sub-total	300		
Orocuina Area				
5	Orocuina E	150	Grain, vegetable	
6	Orocuina F	250	Grain, vegetable	
7	Orocuina G	100	Grain, vegetable	
8	Orocuina H	540	Grain, vegetable	
	Sub-total	1,040		
	Total	1,680		

Remarks: For more details see ANNEX H

Source : Field survey

Table 16 DISCHARGE VOLUME OF CHOLUTECA RIVER AT HERNANDO LOPEZ

C.A.= 1,565 km^2
Unit: $10^6 m^3$

	J	F	M	A	M	J	J	A	S	O	N	D	Total
1954								36.3	195	162	19.2	7.4	
55	6.5	5.8	5.7	5.4	5.0	7.0	120	67.5	129	231	55.1	19.7	657.7
56	1 .4	8..	5.6	5.3	14.3	88.7	48.6	15.4	39.4	36.2	14.7	12.7	30(.
57	12.5	7.6	5.5	5.1	28.1	75.5	18.4	19.4	50.5	40.8	10.5	9.5	283.1
58	5.7	3.8	3.7	3.0	62.4	135	61.5	32.0	25.4	62.8	10.0	7.5	412.8
59	7.7	5.5	4.5	3.9	23.9	36.1	12.4	23.3	18.9	54.7	16.6	10.5	218.(
1960*	.0	3.7	3.3	3.1	13.7	104	19.1	39.7	88.1	123	17.5	10.3	430.7
61*	9.8	7.9	6.9	5.4	5.5	23.6	30.2	15.6	39.3	31.0	28.9	11.5	215 6
62*	10.4	7.1	5.6	5.3	21.1	64.1	17.5	32.1	69.3	129	12.2	10.8	385 (
63*	8.1	5.6	4.9	4.5	4.4	25.1	30.1	12.3	30.7	45.9	42.4	6.2	220.2
64	5.1*	3.7*	3.5*	3.1*	2.9*	85.2	104	15.1	54.7	70.1	7.1	5.8	360.(
65	2.6	2.6	1.8	1.5	21.4	43.0	16.5	11.5	247	78.2	35.3	12.5	474.(
66	7.4	4.5	4.6	4.4	48.3	80.5	74.1	26.3	39.1	63.0	12.7	7.9	372.(
67	6.8	5.2	4.5	10.4	3.5	13.3	14.2	9.4	32.8	33.0	10.0	5.7	148.(
68	4.5	2.7	1.9	1.8	51.8	160	27.6	21.9	86.6	64.2	37.6	11.9	472.7
6.	9.6	3.9	3.0	1.9	16.8	204	72.4	130	181	203	38.5	21.3	885.4
1970	8.7	6.2	3.9	8.1	15.4	19.9	50.6	91.2	176	75.6	28.5	14.5	499.(
71	6.8	4.6	3.2	2.8	23.5	16.7	16.1	40.8	102	96.0	18.5	7.8	338.
72	5.5	3.2	2.2	2.4	13.9	37.7	7.7	8.4	9.7	8.5*	4.3*	3.3*	105.
73	3.2*	2.8*	3.0*	2.8*	17.3	45.5	43.1	29.2	88.9	175	40.4	9.8	463.
74	6.0	5.1	4.5	3.2	86.9*	41.7	19.3	8.4	104.7*	39.9	12.0	9.9	261.(
75	9.1	6.5	4.9	3.6	14.3	8.0	16.5*	5.2*	220.2*	154	176**	12.6	591.(
76	8.5	6.0	5.1	4.9									
Mean	7.4	5.1	4.1	4.1	23.6	62.6	39.1	31.4	92.2	89.8	29.4	10.4	399 2

Remarks:

* Discharge estimated by rainfall-runoff studies.

** Discharge estimated from direct observation data for 26 days.

Source : Servicios Climatologicos y Hidrologicos, MRN

Table 17 DISCHARGE VOLUME OF CHOLUTECA RIVER AT LOS ENCUENTROS

C.A.= 6,370 km^2

Unit: $10^6 m^3$

	J	F	M	A	M	J	J	A	S	O	N	D	Total
1956											59.5	32.2	
57	43.5	29.5	22.2	19.2	144.5	224.7	44.3	61.0	219.5	198.9	39.5	27.6	1074.4
58	18.4	10.7	9.6	8.7	165.8	370.2	248.7	124.2	81.8	223.9	42.6	22.4	1327.0
59	18.8	12.2	8.0	5.6	41.2	71.2	19.5	45.2	42.1	205.8	38.7	15.7	524.0
1960*	14.1	7.4	5.5	5.5	97.4	237.9	124.7	193.4	232.9	310.6	96.6	35.1	1361.1
61*	30.4	24.4	19.2	15.2	13.4	146.9	156.6	80.6	128.6	146.4	94.8	30.6	888.1
62*	26.4	17.6	11.8	10.2	68.9	159.3	90.2	85.4	141.0	192.7	31.0	22.4	856.9
63*	19.5	12.0	10.9	10.3	9.2	87.6	94.4	50.2	120.8	208.2	156.4	27.1	806.5
64	19.3*	12.2*	11.9*	10.9*	9.6*	335.4*	246.6*	74.5	166.7	292.2	41.3	27.2	1247.8
65	12.1	5.3	5.1	4.4	84.2	133.7	54.6	50.9	368.1	261.3	94.7	36.7	1131.1
66	25.3	14.3	12.7	17.1	138.6	394.2	286.8	128.0	175.0	393.8	65.9	35.9	1685.6
67	26.8	19.8	17.0	36.1	14.7	89.6	56.4	48.7	153.4	111.3	39.5	22.6	635.9
68	20.1	12.8	8.6	8.6	145.0	560.1	108.4	74.5	329.2	308.9	118.0	45.8	1740.0
69	39.0	16.7	14.7	12.7	51.8	580.8	206.2	471.4	534.0	784.9	154.8	44.2	2911.2
1970	17.9	9.5	6.9	7.8	34.1	32.1	137.3	218.3	436.8	329.5	107.6	45.0	1382.8
71	29.1	17.7	12.9	10.1	71.6	52.8	32.9	111.4	318.8	353.6	68.5	31.9	1111.3
72	21.6	14.1	9.8	8.7	50.0	134.5	23.0	28.4	28.8	32.8	20.4	12.0	384.1
73	9.1	5.5	4.2	5.6	33.6	89.4	97.2	72.6	240.3	542.0	170.3*	35.7*	1355.5
74*	18.6	9.0	7.1	6.4	238.9	205.2	103.3	105.4	507.8	334.6	74.1	21.8	1632.2
75*	12.5	6.9	6.7	6.7	27.9	8.8	33.9	51.1	592.1	544.1	375.6	73.8	1740.1
76*	24.8	13.8	8.6	7.3									
Mean	22.3	13.6	10.7	10.9	75.8	206.0	113.9	109.2	253.6	307.7	94.5	32.3	1250.5

Remarks:

* Discharge estimated by rainfall-runoff studies.

Source : Servicios Climatologicos y Hidrologicos, MRN

Table 18 SOILS IN THE CHOLUTECA PLAIN

Symbol	Physiography	Order	Hectareage		
			Western Plain	Eastern Plain	Total
Ll	Flood Plain	Inceptisol	410	180	590
Llt	Flood Plain	Entisol	2,770	690	3,460
Jd, Gt, Mn					
Pq, Ps	Flood Plain	Mollisol	15,960	180	16,140
Tt	Terrace	Vertisol	1,410	290	1,700
Sp	Terrace	Ultisol	-	320	320
Ch1, Ch2, Mc	Terrace	Alfisol	620	11,230	11,850
GL-Sm, GL-GC3 Chp-Cr	Hill	Alfisol	300	790	1,090
	Water		930	220	1,150
			22,400	13,900	36,300

Table 19 LAND CAPABILITY CLASSIFICATION IN THE CHOLUTECA PLAIN

Land Class	Western Plain ha	%	Eastern Plain ha	%	Total ha	%
I	6,740	30.0	110	0.8	6,850	18.9
II	6,750	30.1	1,420	10.2	8,170	22.5
III	7,590	33.9	9,650	69.4	17,240	47.5
IV	130	0.6	2,200	15.8	2,330	6.4
VI	260	1.2	300	2.2	560	1.5
Water	930	4.2	220	1.6	1,150	3.2
Total	22,400	100.0	13,900	100.0	36,300	100.0

Table 20 PRESENT LAND USE IN THE CHOLUTECA PLAIN

Unit: ha

Land Category	Western Plain	Eastern Plain	Total
Upland and paddy field			
Sugar cane	5,170	30	5,200
Rotation of maize, sorghum, etc.	2,270	530	2,800
Cotton	740	150	890
Rice paddy	360	160	520
Pasture, Forest	10,930	10,580	21,510
Sub-total	19,470	11,450	30,920
Bush & scrub	490	550	1,040
Village	420	290	710
Road, water, etc.	2,020	1,610	3,630
Total	22,400	13,900	36,300

Source: Data from Cadastro office

Table 21 PRESENT AGRICULTURAL PRODUCTION IN THE CHOLUTECA PLAIN

Description	yield. (ton/ha)	Western Plain		Eastern Plain		Total	
		Crop Area (ha)	Production (ton)	Crop Area (ha)	Production (ton)	Crop Area (ha)	Production (ton)
Sugar cane:							
- estate farm	78.6	3,400	267,200	-	-	3,400	267,200
- outgrowers' farm	70.0	1,640	114,800	30	2,100	1,670	116,900
Total:		5,040	382,000	30	2,100	5,070	384,100
Maize:							
- semi-mechanized	2.0	1,110	2,200	360	700	1,470	2,900
- traditional	1.6	370	600	120	200	490	800
Total:		1,480	2,800	480	900	1,960	3,700
Sorghum:							
- semi-mechanized	2.0	80	200	-	-	80	200
- traditional	1.6	110	100	10	0	120	100
Total:		190	300	10	0	200	300
Cotton	2.0	740	1,500	150	300	890	1,800
Sesame	1.3	130	200	10	0	140	200
Rice (paddy)	3.0	360	1,100	160	500	520	1,600
Melon	5.2	260	1,400	20	100	280	1,500
Water melon	8.0	210	1,700	10	100	220	1,800
Livestock:							
- milk	190l	10,930	2,100kl	10,580	2,000kl	21,510	4,100kl
- meat (liveweight)	130kg	10,930	1,400	10,580	1,400	21,510	2,800

Remarks: (1) Sugar estate of 130 ha is not operated.

(2) 1,600 paddy tons is equivalent to 1,000 tons of polished rice.

Source : The present agricultural production in the Choluteca plain is estimated on the basis of the results of farm survey and data from ACENSA, ACHSA, Cooperativa Agropecuaria Algodonera del Sur Ltda and MRN Choluteca office.

Table 22 PRESENT FARM BUDGET

	Cooperative Member	Less than 50 ha	50 - 200 ha	More than 200 ha
1. Average Holding Size (ha)	5.8	12.6	87.4	401.5
2. Crop Area (ha)				
Sugar cane	0.6	1.3	9.1	40.9
Cotton	0.7	0.3	4.1	18.6
Maize	0.5	1.2	8.2	37.0
Sorghum	0.1	0.1	0.9	5.5
Sesame	-	0.1	0.6	3.2
Rice	0.1	0.3	2.1	9.3
Melon	0.4	0.2	1.5	-
Water melon	0.3	0.2	1.2	-
Pasture	3.5	8.6	59.7	287.0
3. Gross Income (10^3)				
3.1 Production income	2.20	2.80	20.7	84.7
3.2 Labor income	-	0.40	-	-
Total 3.1 & 3.2	2.20	3.20	20.7	84.7
4. Production Cost (10^3)				
4.1 Seed	0.04	0.07	0.50	1.98
4.2 Fertilizer	0.17	0.27	1.75	6.71
4.3 Chemical	0.15	0.40	1.57	6.01
4.4 Hired labor	-	-	4.97	20.28
4.5 Machinery cost	0.14	0.20	1.87	6.98
4.6 Transportation	0.10	0.18	1.29	5.56
4.7 Others	0.10	0.18	1.31	5.31
Total 4.1 to 4.7	0.70	1.30	13.26	52.83
5. Net Income (10^3):3-4	1.50	1.90	7.44	31.87
6. Tax (10^3)	0	0	0.64	10.90
7. Living Expense (10^3)	1.20	1.20	5.40	6.40
8. Net Surplus (10^3):5-6-7	0.30	0.70	1.40	14.57

Source: Field survey

Table 23 OPERATION RECORD OF ACHSA

Year	Operation Days		Cane Milled	Daily Milling Rate	Sugar Produced	Sugar Recovery
	Gross	Net	(ton)	(ton)	(ton)	(%)
1968 69	158	78	84,650	1,085	4,940	5.8
1969 70	155	99	98,680	997	7,500	7.6
1970 71	139	95	101,160	1,065	9,640	9.5
1971 72	152	119	123,710	1,040	11,990	9.7
1972 73	174	129	115,260	1,204	12,370	8.0
1973 74	177	131	170,690	1,303	16,240	9.5
1974 75	185	150	184,030	1,227	18,070	9.8
1975 76	190	154	191,590	1,244	19,090	10.0
1976 77	226	191	226,610	1,186	21,110	9.3

Remarks: Certain volume of sugar cane was purchased from ACENSA in 1976 77

Source : Data from ACHSA office

Table 24 EXISTING SURFACE IRRIGATION IN THE CHOLUTECA PLAIN

No.	Name	Net ha	Main crop	
1.	ACHSA	990	Sugar cane	
2.	ACENSA, right bank	420	Sugar cane	
3.	ACENSA, left bank	360	Sugar cane	
4.	MRN ha hujosa Experimental Station	30	Rice, sorghum, beans	
5.	Oscar Narvaez	34	Rice, beans	
6.	Abraham Williams	40	Pasture	
7.	Mr. Flores	21	Sorghum, maize	
8.	David Moran	35	Rice	
9.	Abiloo Martinez	100	Rice	
10.	Sr. Cano	160	Rice	Sampile river
	Total	2,190		

Remarks: It is estimated that the ACHSA pump is capable of irrigating only 850 ha.

Source : Field survey

Table 25 EXISTING GROUNDWATER IRRIGATION IN THE CHOLUTECA PLAIN

No.	Name	Nos. of Well	Net ha	Main Crop
1.	ACHSA	18	550	Sugar cane
2.	ACENSA	20	860	Sugar cane
3.	Buenavist Coop.	9	216	Sugar cane
4.	Fuerzas Onidas Coop.	*	42	Sugar cane
5.	Herrado Coop.	*	66	Sugar cane
6.	Independence Coop.	*	74	Sugar cane
7.	Cesar Ortega	2	55	Rice
8.	Andres Lardizabal	4	155	Rice
9.	Luis Lardizable	1	34	Rice
10.	Roberto Pliva	1	35	Rice
11.	Jorge Maradiaga	1	20	Rice, Sorghum
12.	Carnery Union	*	18	Sugar cane
	Total		2,225	

* : Nos. of well were not investigated.

Source : Field survey

Table 26 POPULATION AND HOUSEHOLD IN THE CHOLUTECA PLAIN

Alder/Caserio	Population	Household
Western Plain		
El Palenque, C	823	183
La Joyada, M	947	197
Los Llanitos, M	1,489	268
Los Mangles, M	703	127
Monjaras, M	6,281	1,143
Punta Raton, M	416	63
San Jose, M	1,075	206
Santa Cruz, M	1,254	251
Sub-total	12,988	2,438
Eastern Plain		
El Carrizo, C	371	94
San Jose de Landa, C	373	86
Marcovia, M	2,720	607
Gervasia, M	461	93
Sub-total	3,925	880
Total	16,913	3,318

Remarks; C: Choluteca Municipio, M: Marcovia Municipio

Source : Ref. 9

Table 27 HOUSEHOLD AND FARM AREA BY HOLDING SIZE IN THE CHOLUTECA PLAIN

Holding Size	Western Plain	%	Eastern Plain	%	Total	%
Household in Number						
Landless	1,239	59.9	489	66.0	1,728	61.4
Less than 5 ha	132	6.4	106	14.3	238	8.5
5 - 10 ha	213	10.3	29	3.9	242	8.6
10 - 50 ha	439	21.2	70	9.5	509	18.1
50 - 100 ha	22	1.1	16	2.2	38	1.4
100 - 200 ha	12	0.6	19	2.6	31	1.1
200 - 300 ha	6	0.3	4	0.5	10	0.4
300 - 500 ha	3	0.1	2	0.3	5	0.2
More than 500	4	0.2	5	0.7	9	0.3
Total	2,070	100.0	740	100.0	2,810	100.0
Farm Area in Ha						
Less than 5 ha	270	1.4	200	1.7	470	1.5
5 - 10 ha	1,660	8.5	200	1.7	1,860	6.0
10 - 50 ha	5,820	29.9	1,460	12.8	7,280	23.6
50 - 100 ha	1,470	7.6	980	8.5	2,450	7.9
100 - 200 ha	1,500	7.7	2,440	21.3	3,940	12.7
200 - 300 ha	1,230	6.3	940	8.2	2,170	7.0
300 - 500 ha	990	5.1	640	5.6	1,630	5.3
More than 500 ha	3,000	15.4	4,590	40.1	7,590	24.6
Sugar cane estate	3,530	18.1	-	-	3,530	11.4
Total	19,470	100.0	11,450	100.0	30,920	100.0

Source : The number of household and farm area is estimated on the basis of the Cadastro Map from Cadastro office at Tegucigalpa.

Table 28 PRINCIPAL FEATURE OF THE PROJECT (1/3)

1. San Fernando Dam and Power Station

1.1 Reservoir

Catchment area:	1,665 km^2
Annual inflow:	425 x 10^6 m^3
Gross storage capacity:	385 x 10^6 m^3
Active storage capacity:	330 x 10^6 m^3
Reservoir area:	22 km^2
Flood water surface:	EL.828.5 m
High water surface:	EL.823.5 m
Low water surface:	EL.794.5 m

1.2 Dam & Spillway

Type of dam:	Concrete gravity
Crest elevation:	EL.829.0 m
Crest length:	217.5 m
Dam height:	93.5 m
Dam volume:	310,000 m^3
Design flood inflow:	5,280 m^3/s
Spillway capacity:	2,470 m^3/s
River outlet:	1 m dia. Howell-Bunger valve

1.3 Power Station

Turbine:	14.3 MW vertical shaft Francis turbine
Generator:	17.5MVA
Transformer:	17.5MVA
Transmission line:	69 kV single circuit 25 km long line
Substation:	17.5MVA 3-phase

2. Choluteca Plain Irrigation & Drainage System

2.1 Irrigable Area

Net area commanded by new irrigation system:	14,370 ha
Net area commanded by existing pumps:	1,630 ha
Total	16,000 ha
Gross area:	22,400 ha

Table 29 PRINCIPAL FEATURE OF THE PROJECT (2/3)

2.2 EL Papalon Intake Weir	
Type of weir:	Ogee crest concrete weir on floating foundation
Crest elevation:	EL.23.8 m
Crest length:	140 m
Height of weir:	4.8 m
Design flood discharge:	2,600 m^3/s
Intake water level:	EL.23.8 m
Maximum intake discharge:	20.45 m^3/s
2.3 Canal & Road System	
Main canals:	26.3 km
Branch canals:	46.5 km
Secondary canals:	84.8 km
Drainage canals:	144.4 km
Farm roads:	121.5 km
2.4 On-farm Development	
Standard farm size:	600 m x 200 m
3. Investment Cost	
3.1 Dam & Power Station:	$33.18 x 10^6
3.2 Irrigation & Drainage System:	$23.12 x 10^6
3.3 Engineering & Administration:	$9.00 x 10^6
3.4 Compensation:	$0.82 x 10^6
3.5 Contingencies:	$21.90 x 10^6
Total	$88.02 x 10^6

Table 30 PRINCIPAL FEATURE OF THE PROJECT (3 3)

4. Output		
4.1 Crop		
Sugar cane:		800,000 tons
Maize	:	20,400 tons
Sorghum	:	3,200 tons
Beans	:	1,600 tons
Rice	:	9,600 tons
Cotton	:	15,300 tons
Others	:	10,200 tons
4.2 Power		
Peak power		14 Mw
Energy		53.4 Gwh
6. Small Irrigation made Possible by the Project		
6.1 Number of Projects		8
6.2 Net irrigable area		1,680 ha
7. Internal Rate of Return		
Economic rate of return:		12.2 %
Financial rate of return:		11.8 %

Table 31 PROPOSED LAND USE IN THE PROJECT AREA

Cropping Pattern	Hectareage	%
1. Sugar cane	6,760	42.2
2. Maize-Cotton	3,500	21.9
3. Sorghum-Cotton	800	5.0
4. Beans-Cotton	800	5.0
5. Maize-Sesame	800	5.0
6. Maize-Melon	400	2.5
7. Maize-Water melon	400	2.5
8. Rice-Rice	1,600	10.0
9. Vegetable	800	5.0
10. Pasture	140	0.9
Sub-total: Net Irrigable Area	16,000	100.0
Village	420	
Road, canal, water, etc.	5,980	
Total: Gross Area	22,400	

Table 32 LABOR REQUIREMENT

Unit: 10^3 man-day

Month	Net Workable Days	Farm Labor	Operator
JAN	28	236	4.2
FEB	25	198	5.8
MAR	28	181	6.3
APR	27	120	4.0
MAY	19	74	2.6
JUN	18	52	3.9
JUL	23	77	6.0
AUG	23	52	6.5
SEP	15	14	4.7
OCT	16	20	3.2
NOV	27	91	2.8
DEC	28	183	2.9
Total	277	1,298	52.9

Table 33 MACHINERY REQUIREMENT

Unit: $10^3

Description	Nos.	Unit Price	Amount
Tractor 70 PS	156	12.0	1,872
Attachment			
Plow	113	1.3	147
Harrow	74	1.7	126
Fertilizer distributor	130	3.2	416
Digger	80	1.2	96
Ridger	83	1.2	100
Cultivator	72	1.5	108
Tractor trailer	64	3.5	224
Rice combine	10	50.0	500
Duster-sprayer	54	0.5	27
Repair-shop equipment	L.S.		40

Table 34 FERTILIZER AND CHEMICAL REQUIREMENT

Description	Unit	Quantity
Fertilizer		
Compound fertilizer;		
- 12 : 24 : 12	ton	2,890
- 15 : 15 : 15	ton	3,140
Urea	ton	4,380
Agro-chemicals		
Herbicides (wettable)	ton	53
Herbicides (emulsion)	kl	3
Insecticides (emulsion)	kl	260
Insecticides (dust)	ton	179
Fungicides (wettable)	ton	19
Rodenticides	ton	41

Table 35 INCREASE IN AGRICULTURAL PRODUCTION UNDER WITH-PROJECT CONDITION

Description	Without-Project Crop Area (ha)	Yield (ton/ha)	Production (ton)	With-Project Crop Area (ha)	Yield (ton/ha)	Production (ton)	Production Increase (ton)
Sugar cane:							
- estate farm	3,400	78.6	267,200	3,530	118.3	417,600	
- outgrowers' farm	1,640	70.0	114,800	1,640	118.3	194,000	
- expanded out-growers' farm	6,800	61.4	417,500	1,590	118.3	188,100	
Total	11,840		799,500	6,760		799,700	200
Maize:							
- semi-mechanized	1,110	2.0	2,200	5,100	4.0	20,400	
- traditional	370	1.6	600				
Total	1,480		2,800	5,100		20,400	17,600
Sorghum:							
- semi-mechanized	80	2.0	200	800	4.0	3,200	
- traditional	110	1.6	100				
Total	190		300	800		3,200	2,900
Beans	-		-	800	2.0	1,600	1,600
Cotton	740	2.0	1,500	5,100	3.0	15,300	13,800
Sesame	130	1.3	200	800	1.5	1,200	1,000
Rice (paddy)	360	3.0	1,100	3,200	5.0	16,000	14,900
Melon	260	5.2	1,400	400	6.5	2,600	1,200
Water melon	210	8.0	1,700	400	12	4,800	3,100
Vegetable	-		-	800	20	16,000	16,000
Livestock:							
- milk	4,130	190ℓ	780	140	190ℓ	30	-750
- meat (liveweight)	4,130	130kg	540	140	130kg	20	-520

Remarks: 16,000 paddy tons is equivalent to 9,600 tons of polished rice.

Table 36 A-PAN EVAPORATION DATA AND ESTIMATED POTENTIAL EVAPOTRANSPIRATION

Unit: mm

Month	(1)	(2)	(3)	(4)	(5)
Jan	290	229	270	292	305
Feb	308	209	266	282	290
Mar	315	212	268	275	321
Apr	283	185	274	284	318
May	187	148	211	190	209
Jun	171	138	170	149	150
Jul	200	145	233	205	234
Aug	169	136	195	161	194
Sep	148	127	156	102	118
Oct	160	126	152	125	135
Nov	195	117	205	187	206
Dec	252	264	258	267	277
Total	2,588	1,986	2,658	2,519	2,757

Remarks: (1) USBR standard A pan evaporation in 1970 - 1976 at Choluteca Meteorological Station.

(2) Estimated evapotranspiration by the modified Blaney-Cliddle method for 1966-1975 at Choluteca.

(3) Estimated evapotranspiration by the modified Penmam method for 1966-1975 at Choluteca.

(4) Estimated evapotranspiration by the Christiansen - Hargreaves method for 1970-1975 at Choluteca.

(5) Estimated evapotranspiration by the Hargreaves method for 1966-1975.

Table 37 MONTHLY RAINFALL RECORD IN THE CHOLUTECA PLAIN

Unit: mm

	1967	1968	1969	1970	1971	1972	1973	1974	1975	Aver-age	(H)
Jan	0	0	6	0	1	0	0	0	1	1	0
Feb	1	0	0	0	1	0	0	0	0	0	0
Mar	27	0	17	0	0	49	2	0	2	11	3
Apr	34	27	65	47	1	27	24	0	0	25	17
May	4	442	187	234	335	326	212	214	243	244	189
Jun	378	590	358	222	186	231	272	384	117	304	235
Jul	96	105	185	431	112	204	240	39	178	177	137
Aug	152	198	425	386	378	131	502	203	280	295	228
Sep	289	441	447	500	345	178	580	544	522	427	331
Oct	144	377	506	249	408	216	534	138	330	322	248
Nov	16	70	69	115	113	48	10	22	287	83	62
Dec	20	1	0	1	1	0	22	1	0	5	2
Total	1161	2251	2265	2185	1881	1410	2398	1545	1708	1867	1452

Remarks: Arithmetic mean of monthly values at the Choluteca Meteorological Station and at the raingauge in ACHSA farm.
(H): rainfall having 90% probability of exceedance.

Table 38 IRRIGATION DIVERSION REQUIREMENT

(Unit: $10^6 m^3$)

Month	S.J.de Flores 1,480 ha	Oropoli 180 ha	Morolica 300 ha	Orocuina 1,370 ha	Choluteca Project 16,000 ha	Total 19,330 ha
Jan	1.3	0.4	0.8	3.8	46.6	52.1
Feb	1.9	0.3	0.6	2.8	31.8	37.4
Mar	2.6	0.5	1.1	4.8	32.6	41.6
Apr	2.8	0.6	1.3	6.1	45.7	56.5
May	1.1	0.2	0.5	2.2	15.2	19.2
Jun	0.2	0.1	0.3	1.4	3.2	5.2
Jul	1.5	0.1	0.2	1.1	9.3	12.2
Aug	1.0	0	0	0	0	1.0
Sep	1.8	0	0	0	0	1.8
Oct	1.9	0.1	0.2	0.7	1.6	4.5
Nov	1.2	0.3	0.7	3.2	29.4	34.8
Dec	1.7	0.5	1.0	4.8	59.1	67.1
Total	19.0	3.1	6.7	30.9	274.5	334.2

Table 39 INVESTMENT COST COMPARISON OF SAN FERNANDO AND MOROLICA IRRIGATION DAM

(Unit: $\$10^6$)

	San Fernando	Morolica
1. Preparatory work	1.64	0.53
2. Diversion work	0.64	5.83
3. Dam & spillway	19.91	27.94
4. Outlet work	0.28	0.41
5. Relocation of highway	1.32	-
Sub-total	23.79	34.71
6. Engineering & administration	3.57	5.21
7. Land compensation	0.61	1.82
8. Contingencies	8.95	13.35
Total	36.92	55.09

Table 40 SCALE OPTIMIZATION OF SAN FERNANDO DAM

Case	1	2	3	4
HWS (EL.-m)	817.5	821.5	823.5	826.5
LWS (EL.-m)	794.5	794.5	794.5	794.5
Active Storage ($10^6 m^3$)	210	285	330	400
Dam Height (m)	88	92	93.5	97
Installed Capacity (MW)	9	10	14	17
Dependable Peak (MW)	0	10	14	17
Annual Energy (GWh)	45.0	52.0	58.4	62.0
Capitalized Power Benefit				
Capacity Benefit ($\$10^6$)	-	7.01	9.81	11.92
Energy Benefit ($\$10^6$)	6.26	7.23	8.12	8.62
Total	6.26	14.24	17.93	20.54
Additional Cost Over Irrigation Dam				
Dam Increase ($\$10^6$)	-	1.97	3.01	4.63
Other Civil Work ($\$10^6$)	1.90	1.90	2.23	2.43
Equipment ($\$10^6$)	3.57	3.63	4.64	5.40
Engineering & Contingencies ($\$10^6$)	1.45	1.99	2.62	3.30
Interest During Construction ($\$10^6$)	0.80	1.10	1.45	1.83
Capitalized O&M ($\$10^6$)	0.78	0.78	0.78	0.78
Total	8.50	11.37	14.73	18.37
Benefit less Cost ($\$10^6$)	-2.24	2.87	3.20	2.17

Table 41 LENGTH OF MAIN, BRANCH AND SECONDARY CANALS

(Unit : km)

	Main	Branch	Secondary
Upper Main Canal	12.8		
Secondary canal R-0-1			5.0
Secondary canal R-0-2			9.5
Secondary canal R-0-3			8.0
Secondary canal R-0-4			8.0
Left Main Canal	8.6		
Secondary canal R-0-7			2.3
Left Branch Canal 1		9.0	
Secondary canal L-1-1			4.5
Secondary canal L-1-2			2.0
Secondary canal L-1-3			2.0
Secondary canal L-1-4			1.0
Secondary canal L-1-5			0.5
Left Branch Canal 1a		2.5	
Secondary canal L-1a-1			1.5
Secondary canal L-1a-2			2.5
Secondary canal L-1a-3			1.5
Right Branch Canal 1		7.0	
Secondary canal R-1-1			2.8
Secondary canal R-1-1a			4.5
Secondary canal R-1-1b			4.0
Secondary canal R1-2			5.0
Right Main Canal	4.9		
Secondary canal R-0-5			3.6
Right Branch Canal 2		11.8	
Secondary canal R-2-1			3.7
Secondary canal R-2-2			2.2
Secondary canal R-2-3			1.5
Secondary canal R-2-4			2.8
Right Branch Canal 3		9.0	
Secondary canal R-3-1			2.4
Right Branch Canal 4		7.2	
Secondary canal R-4-1			2.2
Secondary canal R-4-2			1.8
Total	26.3	46.5	84.8

Table 42 NUMBER OF RELATED STRUCTURES

Description	Irrigation	Drainage	On-farm
1. Intake Weir	1	-	-
2. Desilting Basin	1	-	-
3. Bifurcation Structure	1	-	-
4. Turnout	287	-	1,150
5. Cross Regulator	78	-	-
6. Drop	51	11	-
7. Culvert	36	-	-
8. Spillway	28	-	-
9. Siphon	1	-	-
10. Drainage Culvert	-	22	-
11. Bridge	-	3	-
12. Submergible Bridge	-	1	-
13. Booster Pump Station	1	-	-
14. Division Box	-	-	5,800

Table 43 LENGTH OF MAIN AND COLLECTOR DRAIN CANALS

Unit: km

	Main	Secondary
Right Main Drain Canal-1	15.0	
Secondary drain canal RD-1-1		1.5
Right Main Drain Canal 2	21.3	
Secondary drain canal RD-2-1		2.5
Secondary drain canal RD-2-2		1.2
Right Main Drain Canal 3	7.5	
Secondary drain canal RD-3-1		2.5
Secondary drain canal RD-3-2		0.5
Secondary drain canal RD-3-3		2.5
Secondary drain canal RD-3-3a		3.2
Right Main Drain Canal 3a	1.9	
Righr Main Drain Canal 4	14.0	
Secondary drain canal RD-4-1		1.6
Secondary drain canal RD-4-2		1.0
Right Main Drain Canal 5	9.4	
Right Main Drain C nal 6	8.1	
Right Main Drain Canal 7	6.5	
Right Main Drain Canal 7a	3.9	
Right Main Drain canal 8	1.2	
Right Main Drain Canal 9	3.1	
Left Main Drain Canal 7	2.0	
Left Main Drain Canal 7b	3.5	
Secondary drain canal LD-7b-1		4.0
Secondary drain canal LD-7b-1a		1.0
Left Main Drain Canal 14	3.0	
Left Main Drain Canal 15	6.0	
Left Main Drain Canal 16	1.5	
Left Main Drain Canal 17	1.5	
Left Main Drain Canal 18	5.0	
Left Main Drain Canal 19	2.0	
Left Main Drain Canal 20	1.5	
Total	121.9	22.5

Table 44 TOTAL LENGTH OF TERTIARY ROADS, TERTIARY CANALS, COLLECTOR DRAINS, FARM DITCHES AND DRAIN DITCHES

Unit : km

Tertiary Roads	220
Tertiary Canals	180
Collector Drains	220
Farm Ditches	500
Field Drains	500

Table 45 EXAMPLE LIST OF CONSTRUCTION CONTRACTS

1. International Contract

   1.1 Dam and power station

   1.2 Penstock and intake gate

   1.3 Spillway gate

   1.4 Generating equipment and outlet valve

   1.5 Transmission line and substation

   1.6 Telecommunication system

   1.7 Intake weir

   1.8 Irrigation, drainage and road system in Division 1

   1.9 Irrigation, drainage and road system in Division 2

   1.10 Irrigation, drainage and road system in Division 3

2. Local Contract

   2.1 Access road, building and quarter for dam construction

   2.2 Relocation of highway

   2.3 Building and quarter for irrigation system

   2.4 Reclamation and on-farm construction in Division 1

   2.5 Reclamation and on-farm construction in Division 2

   2.6 Reclamation and on-farm construction in Division 3

Table 46 MAJOR MATERIAL REQUIREMENT

Material	Requirement
San Fernando Dam and Power Station	
Cement Type I	14,000 t
" Type II	63,000 t
Reinforcement Steel	1,500 t
Timber	4,500 m^3
Explosives	30 t
P.O.L.	
Diesel high speed	5,500 kℓ
Diesel oil	170 kℓ
Gear oil	35 kℓ
Hydraulic	40 kℓ
Grease	15 t
Choluteca Plain Irrigation System	
Cement Type I	15,200 t
Reinforcement Steel	810 t
Timber	1,340 m^3
Gravel for road surfacing	42,000 m^3
Gate and trash rack	400 t
Steel sheet piles	750 t
Precast concrete pipes	4,800 m
Pump and motor	6 sets
Sand for concrete	33.900 m^3
Concrete coarse aggregate	43,900 m^3

Table 47 LABOR REQUIREMENT

Categories	Requirement (man-year)	Average (persons)	Peak (persons)
San Fernando Dam and Power Station			
Contractor's Staff	60	20	30
Technicians from Neighboring Countries	120	40	60
Honduran Labor			
Skilled	240	80	120
Semi-skilled	750	250	370
Unskilled	1,500	500	750
Choluteca Plain Irrigation System			
Contractor's Staff	120	30	45
Technicians from Neighboring Countries	30	8	12
Honduran Labor			
Skilled	170	42	63
Semi-skilled	221	55	83
Unskilled	960	240	360

Table 48 MAJOR CONSTRUCTION PLANT AND EQUIPMENT

Item	Capacity	Nos.
San Fernando Dam and Power Station		
Bulldozer	13 t	5
"	22 t	8
Tractor Shovel	1.2 m^3	4
"	1.9 m^3	2
Power Shovel	0.35 m^3	2
Motor Grader	9 t	1
"	8 t	25
"	12 t	5
Ordinary Truck	4 t	2
"	8 t	2
Water Tank	8 t	2
Tank Lorry	4 t	1
Trailer	25 t	1
Agitator Truck	3 m^3	3
Pickup	1.5 t	2
Bus	50 persons	1
Concrete Plant	6 m^3	1
"	0.75 m^3	1
Aggregate Plant	250 t/h	1
Cable Crane	7.5 t	2
"	4.5 t	1
Cement Silo	250 t	1
Truck Crane	10 t	1
"	35 t	1
Air Compressor	10.5 m^3/min.	4
"	7.0 m^3/min.	4
Generator	750 kw	3
Crawler Drill	99 m^3/min.	6
Rock Drill	2.7 m^3/min.	18
Pick Hammer	0.9 m^3/min.	15
Boring Machine		5
Grount Pump	100 ℓ/min.	4
Grount Mixer	250 ℓ/min.	4
Submergible Pump	200 ϕ	10
"	100 ϕ	10
"	50 ϕ	10
Winch	3 t	3
"	2 t	2

Item	Capacity	Nos.
Choluteca Plain Irrigation System		
Bulldozer	21 t	9
"	15 t	5
Rake Dozer	21 t	8
Dragline	0.8 m^3	3
Backhoe	0.6 m^3	5
Motor Grader	9 t	8
Tractor Shovel	0.6 m^3	16
"	1.0 m^3	32
Dump Truck	8 t	13
Tamper	80 kg	6
Tyre Roller	8 t	8
Tractor	6 t	2
Slope Form	0.6 m^2	5
Truck Mixer	3 m^3	9
Portable Batcher	0.6 m^3	4
Concrete Mixer	3 m^3	2
Compressor	12 m^3/hr	26
Truck Crane	10 t	4
Truck Crawler Crane	30 t	1
Belt Conveyor	35-10 m	10
Submergible Pump	80ϕ	20
Diesel Hammer	2.5 t	3
Ordinary Truck	6 t	8
Generator	10 kw	20
Pick Hammer		5
Bush Cleaner	2.5 PS	40
Rotary Grass Cutter	50 PS	2

Table 49 INVESTMENT DISBURSEMENT SCHEDULE

(Unit : 10^6US$)

	1978	1979	1980	1981	1982	1983	Total
1. San Fernando Dam & Power Staion							
1.1 Access road & quarter		1.23	0.41				1.64
1.2 Diversion & coffering			0.64				0.64
1.3 Dam & spillway		1.31	4.75	11.07	5.62		22.75
1.4 Intake, penstock & outlet		0.11	0.06	0.17	0.29		0.63
1.5 Powerhouse & tailrace				1.41	0.30		1.71
1.6 Generating equipment		0.62	0.62	0.64	1.38		3.26
1.7 Transmission line & substation			0.20	0.23	0.80		1.23
1.8 Highway relocation				0.91	0.41		1.32
Sub-total		3.27	6.68	14.43	8.80		33.18
2. Choluteca Plain Irrigation System							
2.1 Communication system & quarter		0.56	0.32				0.88
2.2 El Papalón intake weir			1.03	1.29	1.28		3.60
2.3 Main canal system			0.28	2.88	2.82		5.98
2.4 Branch canal system			0.19	1.75	0.14	0.65	2.73
2.5 Secondary canal system			0.07	0.71	0.52	0.26	1.56
2.6 Drainage canal system			0.14	1.26	0.37	0.48	2.25
2.7 Farm road system			0.06	0.53	0.42	0.25	1.26
2.8 On-farm construction			0.14	1.29	0.51	0.56	2.50
2.9 Clearing & reclamation			0.11	1.05	0.51	0.69	2.36
Sub-total		0.56	2.34	10.76	6.57	2.89	23.12
3. Engineering & Administration	1.78	3.27	1.31	1.31	1.31	0.02	9.00
4. Land Compensation		0.10	0.32	0.35	0.05		0.82
Total 1 to 4	1.78	7.20	10.65	26.85	16.73	2.91	66.12
5. Physical Contingency (10%)	0.18	0.72	1.07	2.68	1.67	0.29	6.61
6. Price Contingency (5%/year)	0.10	0.81	1.85	6.36	5.08	1.09	15.29
Total 1 to 6	2.06	8.73	13.57	35.89	23.48	4.29	88.02

Table 50 INVESTMENT DISBURSEMENT SCHEDULE

FOREIGN CURRENCY COMPONENT

(Unit : 10^6 US$)

	1978	1979	1980	1981	1982	1983	Total
1. San Fernando Dam & Power Station							
1.1 Access road & quarter							
1.2 Diversion & coffering			0.49				0.49
1.3 Dam & spillway		0.80	3.11	7.90	4.56		16.37
1.4 Intake, penstock & outlet		0.11	0.06	0.17	0.23		0.57
1.5 Powerhouse & tailrace				0.81	0.18		0.99
1.6 Generating equipment		0.62	0.62	0.62	1.25		3.11
1.7 Transmission line & substation			0.20	0.20	0.62		1.02
1.8 Highway relocation				0.16	0.10		0.26
Sub-total		1.53	4.48	9.86	6.94		22.81
2. Choluteca Plain Irrigation System							
2.1 Communication system & quarter		0.20	0.20				0.40
2.2 El Papalón intake weir			0.83	1.00	1.00		2.83
2.3 Main canal system			0.04	1.43	1.41		2.98
2.4 Branch canal system			0.14	1.26	0.10	0.47	1.97
2.5 Secondary canal system			0.05	0.52	0.38	0.19	1.14
2.6 Drainage canal system			0.09	0.85	0.25	0.32	1.51
2.7 Farm road system			0.04	0.35	0.28	0.17	0.84
2.8 On-farm construction							
2.9 Clearing & reclamation							
Sub-total		0.20	1.49	5.41	3.42	1.15	11.67
3. Engineering & Administration	1.59	2.68	1.23	1.24	1.24	0.02	8.00
4. Land Compensation							
Total 1 to 4	1.59	4.41	7.20	16.51	11.60	1.17	42.48
5. Physical Contingency (10%)	0.16	0.44	0.72	1.65	1.16	0.12	4.25
6. Price Contingency (5%/year)	0.09	0.50	1.25	3.91	3.52	0.44	9.71
Total 1 to 6	1.84	5.35	9.17	22.07	16.28	1.73	56.44

Table 51 INVESTMENT DISBURSEMENT SCHEDULE

LOCAL CURRENCY COMPONENT

(Unit : 10^6 US$)

		1978	1979	1980	1981	1982	1983	Total
1.	San Fernando Dam & Power Station							
1.1	Access road & quarter		1.23	0.41				1.64
1.2	Diversion & coffering			0.15				0.15
1.3	Dam & spillway		0.51	1.64	3.17	1.06		6.38
1.4	Intake, penstock & outlet					0.06		0.06
1.5	Powerhouse & tailrace				0.60	0.12		0.72
1.6	Generating equipment				0.02	0.13		0.15
1.7	Transmission line & substation				0.03	0.18		0.21
1.8	Highway Relocation				0.75	0.31		1.06
	Sub-total		1.74	2.20	4.57	1.86		10.37
2.	Choluteca Plain Irrigation System							
2.1	Communication system & quarter		0.36	0.12				0.48
2.2	El Papalon intake weir			0.20	0.29	0.28		0.77
2.3	Main canal system			0.14	1.45	1.41		3.00
2.4	Branch canal system			0.05	0.49	0.04	0.18	0.76
2.5	Secondary canal system			0.02	0.19	0.14	0.07	0.42
2.6	Drainage canal system			0.05	0.41	0.12	0.16	0.74
2.7	Farm road system			0.02	0.18	0.14	0.08	0.42
2.8	On-farm construction			0.14	1.29	0.51	0.56	2.50
2.9	Clearing & reclamation			0.11	1.05	0.51	0.69	2.36
	Sub-total		0.36	0.85	5.35	3.15	1.74	11.45
3.	Engineering & Administration	0.19	0.59	0.08	0.07	0.07		1.00
4.	Land Compensation			0.10	0.32	0.35	0.05	0.82
	Total 1 to 4	0.19	2.79	3.45	10.34	5.13	1.74	23.64
5.	Physical Contingency (10%)	0.02	0.28	0.35	1.03	0.51	0.17	2.36
6.	Price Contingency (5% year)	0.01	0.31	0.60	2.45	1.56	0.65	5.58
	Total 1 to 6	0.22	3.38	4.40	13.82	7.20	2.56	31.58

Table 52 REPLACEMENT COST

	Amount (10^3)
Spillway gate	792
Intake gate & trashrack	200
Penstock	270
Outlet valve	150
Generating equipment	3,260
Transmission line & sub-station equipment	1,232
Gate & trashrack in irrigation system	1,352
Physical contingency	726
Sub-total	7,982
Less: Salvage value (about 10%)	798
Replacement cost	7,184

Table 53 ESTIMATE OF O&M COST

		Amount (10^3)
1.	San Fernando Dam and Power Station	
	1.1 Personnel cost	120
	1.2 Maintenance and repairing cost	
	- Dam, spillway and reservoir	30
	- Power plant and O&M office	70
	- Transmission line and substation	10
	Sub-total	230
2.	Choluteca Plain Irrigation System	
	2.1 Personnel cost	350
	2.2 Operation, maintenance and depreciation cost of O&M equipment	540
	2.3 Operation, maintenance and depreciation cost of vehicle, office equipment, repair equipment and quarter	30
	2.4 Consumable expenses	10
	Sub-total	930
3.	Extension and Training Services	
	3.1 Personnel cost	120
	3.2 Operation, maintenance and despreciation cost of vehicle and equipment	40
	Sub-total	160
4.	Physical Contingency (10%)	130
	Total	1,450

Table 54 STAFF REQUIRED FOR THE SAN FERNANDO AND CHOLUTECA PLAIN CONSTRUCTION OFFICE

	Staff
Project Manager	1
San Fernando Construction Office	
Resident manager	1
Administration Department	
Chief	1
Clerk	1
Accountant	1
Secretary	3
Driver	8
Progress Control Department	
Construction engineer	1
Secretary	1
Construction Department	
Chief	1
Civil engineer	1
Assistant civil engineer	2
Architects	1
Assistant architects	1
Secretary	2
Electrical & Mechanical Department	
Chief	1
Electrical engineer	1
Mechanical engineer	1
Secretary	1
Laboratory	
Chief	1
Material engineer	1
Assistant material engineer	2
Secretary	1

(to be continued)

	Staff
Choluteca Plain Construction Office	
Resident manager	1
Administration Department	
Chief	1
Clerk	1
Accountant	1
Secretary	3
Driver	8
Progress Control Department	
Construction engineer	1
Secretary	1
Construction Department	
Chief	1
Architects	1
Civil engineer	1
Assistant civil engineer	2
Irrigation engineer	8
Assistant irrigation engineer	16
Secretary	2
Inspector	12
Mechanical and Electrical Department	
Chief	1
Electrical engineer	1
Mechanical engineer	2
Assistant mechanical engineer	4
Skilled labor	4
Secretary	1
Laboratory	
Material engineer	1
Assistant material engineer	2

Table 55 STAFF REQUIRED FOR THE SAN FERNANDO DAM MANAGEMENT OFFICE

	Staff
Resident manager	1
Administration Department	
Chief	1
Clerk	2
Accountant	2
Secretary	2
Warehouse keeper	2
Driver	1
Watchman	2
Operation Department	
Chief	1
Chief Operator	4
Electrical operator of power station	8
Mechanical operator of power station	8
Gate operator	2
Operator of substation	3
Secretary	1
Maintenance Department	
Chief	1
Electrical engineer	1
Mechanical engineer	1
Civil engineer	1
Worker	6
Secretary	1

Table 56 STAFF REQUIRED FOR THE CHOLUTECA WATER MANAGEMENT OFFICE

	Staff
Resident Manager	1
Administration Department	
Chief	1
Clerk	2
Accountant	2
Secretary	2
Warehouse keeper	2
Driver	1
Watchman	2
Operation and Maintenance Department	
Chief	1
Assistant chief	1
Civil engineer	1
Assistant civil engineer	2
Irrigation engineer	8
Assistant irrigation engineer	16
Electrical engineer	1
Driver	7
Foreman	12
Secretary	2
Repair Shop and Motor Pool	
Chief	1
Mechanical engineer	1
Assistant mechanical engineer	4
Driver	2
Secretary	1

Table 57 PRICE OF AGRICULTURAL PRODUCT

Unit : $

Description	Unit	Economic	Financial
Sugar cane	ton	12.6	9.37
Seed cotton	ton	509	362
Maize	ton	180	124
Sorghum	ton	163	102
Beans	ton	264	264
Sesame	ton	330	330
Rice (paddy)	ton	201	187
Melon	ton	208	208
Water melon	ton	72	72
Vegetables (tomatos assumed)	ton	107	107
Milk	kℓ	124	1.4
Cattle (liveweight)	ton	0.61	0.35

Table 58 PRICE OF AGRICULTURAL INPUT

Unit : $

	Unit	Economic	Financial
Seeds, Seedlings			
Sugar cane	ton	12.60	9.37
Cotton seed	kg	0.29	0.32
Maize	kg	0.64	0.44
Sorghum	kg	1.05	0.66
Beans	kg	0.40	0.40
Sesame	kg	0.33	0.33
Rice	kg	0.42	0.39
Melon	kg	13.95	13.95
Water melon	kg	10.00	10.00
Vegetable (tomatos assumed)	kg	10.00	10.00
Fertilizers			
12 : 24 : 12	kg	0.32	0.22
15 : 15 : 15	kg	0.35	0.24
Urea	kg	0.29	0.20
Fungicides			
Daconil	kg	14.36	9.90
Dithane	kg	3.83	2.64
Benlate (M-45)	kg	33.99	23.44
Insecticides			
Furadan	kg	2.39	1.65
Tomaron	l	12.69	8.75
Dipterex	kg	11.60	8.00
Orthene	kg	20.36	14.04
Lannate	kg	34.92	24.08
Aldrin	kg	0.96	0.66
Malathion	kg	5.08	3.50
Herbicides			
Gesaprim	kg	4.71	3.25
2 . 4 - D	l	3.06	2.11
DNA 6	l	4.00	2.76
Atrazine	kg	12.33	8.50

Table 59 NET PRODUCTION VALUE UNDER WITH-PROJECT CONDITION 1/2

(Unit : $ ha)

	Sugar Cane			
Yield (t/ha)	Plant Cane 150	Ratoon Cane 140	Average 118.3	Cotton 3.0
1. Gross Income	1,890	1,764	1,491	1,527
2. Production Cost				
2.1 Seed	76	-	13	7
2.2 Fertilizer	179	179	149	120
2.3 Chemical	27	27	23	312
2.4 Labor	296	256	220	180
2.5 Machinery charge	96	46	46	168
2.6 Transportation	248	231	195	30
2.7 Other costs	46	37	32	53
Total 2.1 to 2.7	966	776	678	870
3. Net Value (1-2)	924	988	813	657

Yield (t ha)	Maize 4.0	Sorghum 4.0	Beans 2.0	Sesame 1.5
1. Gross Income	720	652	528	495
2. Production Cost				
2.1 Seed	10	16	18	1
2.2 Fertilizer	117	117	82	16
2.3 Chemical	66	53	10	21
2.4 Labor	36	26	51	30
2.5 Machinery charge	106	94	100	93
2.6 Transportation	9	9	5	7
2.7 Other costs	17	16	13	10
Total 2.1 to 2.7	361	331	279	208
3. Net Value (1-2)	359	321	249	287

Remarks : (1) Sugar cane average figures were estimated assuming 1-plant, 4-ratoon and 1 fallow.

(2) Machinery charge includes land preparation cost.

Table 60 NET PRODUCTION VALUE UNDER WITH-PROJECT CONDITION 2/2

(Unit : $/ha)

	Rice		
	Wet Season	Dry Season	Melon
Yield (t/ha)	5.0	5.0	6.5
1. Gross Income	1,005	1,005	1,352
2. Production Cost			
2.1 Seed	29	29	21
2.2 Fertilizer	116	116	252
2.3 Chemical	157	157	228
2.4 Labor	24	26	178
2.5 Machinery charge	126	126	54
2.6 Transportation	19	19	34
2.7 Other costs	24	24	44
Total 2.1 to 2.7	495	497	811
3. Net Value (1-2)	510	508	541

	Water Melon	Vegetable (Tomatoes)	Pasture (Cattle Raising)
Yield (t ha)	12.0	20.0	
1. Gross Income	864	2,145	103
2. Production Cost			
2.1 Seed	15	10	2
2.2 Fertilizer	140	252	-
2.3 Chemical	122	471	1
2.4 Labor	138	384	15
2.5 Machinery charge	54	87	6
2.6 Transportation	41	68	-
2.7 Other costs	31	116	2
Total 2.1 to 2.7	541	1,388	26
3. Net Value (1-2)	323	752	77

Remarks : (1) Yield of pasture (cattle raising): 190 ℓ of milk and 130 kg (liveweight) of meat.

(2) Machinery charge includes land preparation cost.

Table 61 NET PRODUCTION VALUE UNDER WITHOUT-PROJECT CONDITION 1/3

(Unit : $/ha)

	Sugar Cane (estate farm)		
	Plant Cane	Ratoon Cane	Average
Yield (t/ha)	100	90	78.6
1. Gross Income	1,260	1,134	990
2. Production Cost			
2.1 Seed	76	-	11
2.2 Fertilizer	129	129	110
2.3 Chemical	35	35	30
2.4 Labor	379	333	292
2.5 Machinery charge	66	23	26
2.6 Transportation	165	149	130
2.7 Other costs	43	33	30
Total 2.1 to 2.7	892	702	629
3. Net Value (1-2)	368	432	361

	Sugar Cane (outgrowers' farm)		
	Plant Cane	Ratoon Cane	Average
Yield (t/ha)	90	80	70
1. Gross Income	1,134	1,008	882
2. Production Cost			
2.1 Seed	126	-	18
2.2 Fertilizer	115	115	98
2.3 Chemical	10	10	9
2.4 Labor	267	271	232
2.5 Machinery	64	-	9
2.6 Transportation	149	132	115
2.7 Other costs	37	27	25
Total 2.1 to 2.7	768	555	506
3. Net Value (1-2)	366	453	376

Remarks: (1) Sugar cane average figures were estimated assuming 1-plant, 5-ratoon and 1-fallow.

(2) Machinery charge includes land preparation cost.

Table 62 NET PRODUCTION VALUE UNDER WITHOUT-PROJECT CONDITION 2/3

(Unit : $/ha)

	Sugar Cane (expanded outgrowers' farm)		
Yield (t ha)	Plant Cane 80	Ratoon Cane 70	Average 61.4
1. Gross Income	1,008	882	774
2. Production Cost			
2.1 Seed	126	-	18
2.2 Fertilizer	115	115	98
2.3 Chemical	10	10	9
2.4 Labor	254	257	220
2.5 Machinery charge	64	-	9
2.6 Transportation	132	116	102
2.7 Other costs	35	25	23
Total 2.1 to 2.7	736	523	479
3. Net Value	272	359	295

		Maize	
Yield (t ha)	Cotton 2.0	Semi-mechanized 2.0	Traditional 1.6
1. Gross Income	1,018	360	288
2. Production Cost			
2.1 Seed	9	10	10
2.2 Fertilizer	110	54	-
2.3 Chemical	271	52	52
2.4 Labor	131	47	101
2.5 Machinery charge	167	47	-
2.6 Trnasportation	21	7	6
2.7 Other costs	113	11	8
Total 2.1 to 2.7	822	228	177
3. Net Value (1-2)	196	132	111

Remarks : (1) Sugar cane average figures were estimated assuming 1-plant, 5-ratoon and 1-fallow.

(2) Machinery charge included land preparation cost.

Table 63 NET PRODUCTION VALUE UNDER WITHOUT-PROJECT CONDITION 3/3

(Unit : $ ha)

	Sorghum		
	Semi-mechanized	Traditional	Sesame
Yield (t/ha)	2.0	1.6	1.3
1. Gross Income	326	261	429
2. Production Cost			
2.1 Seed	11	7	5
2.2 Fertilizer	54	51	106
2.3 Chemical	23	10	21
2.4 Labor	54	79	46
2.5 Machinery charge	36	-	15
2.6 Transportation	7	6	9
2.7 Other costs	9	8	23
Total 2.1 to 2.7	194	164	255
3. Net Value (1-2)	132	97	174

	Rice	Melon	Water Melon	Pasture (Cattle Raising)
Yield (t/ha)	3.0	5.2	8.0	
1. Gross Income	603	1,082	576	103
2. Production				
2.1 Seed	42	28	20	2
2.2 Fertilizer	112	186	109	-
2.3 Chemical	134	176	88	1
2.4 Labor	51	257	149	15
2.5 Machinery	118	79	51	6
2.6 Transportation	11	15	33	-
2.7 Other costs	23	78	23	2
Total 2.1 to 2.7	492	819	473	26
3. Net Value (1-2)	111	263	103	77

Remarks : (1) Yield of pasture (cattle raising) : 190 l of milk and 130 kg (liveweight) of meat.

(2) Machinery charge includes land preparation cost.

Table 64 PROJECT IRRIGATION BENEFIT

Description	With-Project			Without-Project			
	Crop Area (ha)	Unit Value ($)	Amount ($10^3)	Crop Area (ha)	Unit Value ($)	Amount ($10^3)	Benefit ($10^3)
Sugar cane							
- Estate farm	3,530	813	2,870	3,400	361	1,227	
- Outgrowers's farm	1,640	813	1,333	1,640	376	617	
- Expanded out-growers' farm	1,590	813	1,293	6,800	295	2,006	
Sub-total			5,496			3,850	1,646
Maize							
- Mechanized	5,100	359	1,831	-	-		
- Semi-mechanized	-	-		1,110	132	147	
- Traditional	-	-		370	111	41	
Sub-total			1,831			188	1,643
Sorghum							
- Mechanized	800	321	257	-	-	-	
- Semi-mechanized	-	-	-	80	132	11	
- Traditional	-	-	-	110	97	11	
Sub-total			257			22	235
Beans	800	249	199	-	-	-	199
Cotton	5,100	657	3,351	740	196	145	3,206
Sesame	800	287	230	130	174	23	207
Rice							
- Wet season	1,600	510	816	360	111	40	
- Dry season	1,600	508	813	-	-	-	
Sub-total			1,629			40	1,589
Melon	400	541	216	260	263	68	148
Water melon	400	323	129	210	103	22	191
Vegetable	800	752	602	-	-	-	602
Livestock	140	77	11	4,130	77	318	-307
Total			13,951			4,676	9,275

Table 65 PRODUCTION FORGONE IN THE RESERVOIR AREA

Description	Crop Area (ha)	Unit Value ($/ha)	Amount (10^3)
Maize	240	111	27
Sorghum	60	97	6
Pasture	300	77	23
Forest	1,400	40	56
Total	2,000		112

Remarks: Of the total flooded area of 2,200 ha, 200 ha is estimated to be water and other unproductive lands.

Table 66 BENEFIT EXPECTED FROM ASSOCIATED FACILITIES

	With Irrigation			Without Irrigation			
	Crop Area (ha)	Unit Value ($)	Amount ($10^3)	Crop Area (ha)	Unit Value ($)	Amount ($10^3)	Incremental Benefit ($10^3)
San Juan de Flores A&B							
Sugar cane	340	813	276	110	376	41	
Maize	-	-	-	180	111	20	
Livestock	-	-	-	70	77	5	
Sub-total			276			66	210
Morolica C&D							
Rice :							
- wet season	150	510	77	-	-	-	
- dry season	150	508	76	-	-	-	
Maize	135	359	48	70	111	8	
Beans	135	249	34	-	-	-	
Vegetable	15	752	11	-	-	-	
Livestock	-	-	-	180	77	14	
Sub-total			246			22	224
Apacilagua E, F, G&H							
Rice :							
- wet season	520	510	265	-	-	-	
- dry season	520	508	264	-	-	-	
Maize	470	359	169	200	111	22	
Beans	470	249	117	-	-	-	
Sorghum	-	-	-	40	97	4	
Vegetable	50	752	38	-	-	-	
Livestock	-	-	-	850	77	65	
Sub-total			853			91	762
Total			1,375			179	1,196

Table 67 ECONOMIC BENEFIT STREAM

(Unit: 10^6)

Year in Order	Year	Irrigation Benefit	Power Benefit	Production Forgone	Associated Benefit	Total Benefit
1	1978	-	-	-	-	-
2	1979	-	-	-	-	-
3	1980	-	-	-	-	-
4	1981	-	-	-	-	-
5	1982	-	8.02	-0.06	-	7.96
6	1983	2.61	1.35	-0.11	0.48	4.33
7	1984	5.02	1.35	-0.11	0.72	6.98
8	1985	6.87	1.35	-0.11	0.96	9.07
9	1986	8.73	1.35	-0.11	1.20	11.17
10	1987	9.28	1.35	-0.11	1.20	11.72
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28	2005	9.28	1.35	-0.11	1.20	11.72
29	2006	9.28	8.62	-0.11	1.20	18.99
30	2007	9.28	1.35	-0.11	1.20	11.72
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50	2027	9.28	1.35	-0.11	1.20	11.72

Table 68 ESTIMATED ECONOMIC INVESTMENT COST OF THE PROJECT

(Unit: 10^6)

	1978	1979	1980	1981	1982	1983	Total
1. San Fernando Dam & Power Station	-	2.94	6.01	12.99	7.92	-	29.86
2. Choluteca Plain Irrigation System	-	0.50	2.11	9.60	5.91	2.60	20.81
3. Engineering & Administration	1.74	3.22	1.28	1.28	1.28	0.02	8.82
Sub-total	1.74	6.66	9.40	23.96	15.11	2.62	59.49
4. Physical Contingency	0.17	0.67	0.94	2.40	1.51	0.26	5.95
Total	1.91	7.33	10.34	26.36	16.62	2.88	65.44

Table 69 ECONOMIC COST OF ASSOCIATED FACILITIES

(Unit: 10^3)

	San Juan de Flores A & B	Morolica C & L	Orocuina E,F,G & H	Total
Net Hectareage	340	300	1,040	1,680
1. Preparatory work including access road, office building	25	46	40	111
2. Pumping station	384	471	1,411	2,266
3. Irrigation, drainage and road system	87	87	364	538
4. Reclamation & on-farm facilities	57	231	784	1,072
5. Engineering & administration	86	125	385	596
6. Physical contingency	65	96	295	456
7. Total 1 to 6	704	1,056	3,239	4,999
8. Less: transfer payment (15%)	106	158	486	750
9. Economic investment cost	598	898	2,753	4,249
10. Replacement cost	300	300	170	770
11. O & M cost	30	30	90	150

Table 70 ECONOMIC COST STREAM

(Unit: 10^6)

		Investment & Replacement			O & M			
	Year	Dam & Power Station	Irriga-tion System	Associated Facilities	Dam & Power Station	Irriga-tion System	Associated Facilities	Total
1	1978	1.12	0.79	-	-	-	-	1.91
2	1979	5.30	2.03	-	-	-	-	7.33
3	1980	7.45	2.89	-	-	-	-	10.34
4	1981	15.12	11.24	-	-	-	-	26.36
5	1982	9.53	7.09	4.25	-	-	-	20.87
6	1983	0.01	2.87	-	0.23	1.08	0.15	4.34
7	1984	-	-	-	0.23	1.08	0.15	1.46
8	1985	-	-	-	0.23	1.08	0.15	1.46
9	1986	-	-	-	0.23	1.08	0.15	1.46
10	1987	-	-	-	0.23	1.08	0.15	1.46
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28	2005	-	-	-	0.23	1.08	0.15	1.46
29	2006	5.26	1.21	0.77	0.23	1.08	0.15	8.70
30	2007	-	-	-	0.23	1.08	0.15	1.46
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50	2027	-	-	-	0.23	1.08	0.15	1.46

Table 71 ECONOMIC INTERNAL RATE OF RETURN

(Unit: %)

Description	EIRR
1. Project as a Whole	12.2
2. Project Irrigation (16,000 ha)	11.3
3. Project Power Generation (14 MW)	21.0
4. Associated Irrigation (1,680 ha)	11.6

Table 72 RESULTS OF SENSITIVITY TEST

(Unit: %)

Case	Description	EIRR
A	As scheduled	12.2
B	Benefit reduced by 10%	10.9
C	Cost increased by 20%	10.0
D	Benefit delayed by 1 year	10.9
E	B + C	8.9
F	B + D	9.9
G	C + D	9.1
H	B + C + D	8.1

Table 73 FUTURE LAND HOLDING DISTRIBUTION IN THE PROJECT AREA

Description	Net Irrigable Area (ha)	%	Nos. of Household	%
1. Landless			1,290	46.1
2. Settlers under INA program	5,310	33.1	1,294	46.2
3. Less than 50 ha	2,260	14.1	169	6.0
4. 50-200 ha	2,320	14.5	34	1.2
5. More than 200 ha	2,600	16.3	13	0.5
6. Sugar cane estates	3,530	22.0	-	-
Total	16,000	100.0	2,800	100.0

Table 74 FARMER'S CAPACITY-TO-PAY BY TYPE OF LAND HOLDING

	INA Settler	Less than 50 ha	50 ha - 200 ha	More than 200 ha	Sugar cane estate	Associated areas
1. Average Irrigable Area (net ha)	4.1	13.4	68.2	200.0	3,530	5.0
2. Crop Area (ha)						
Sugar cane	0.8	2.3	25.6	64.6	3,530	1.0
Cotton	1.6	5.6	29.4	96.1	-	-
Maize	1.7	6.1	25.0	83.1	-	1.8
Sorghum	0.3	0.9	4.4	13.1	-	-
Beans	0.3	0.9	4.4	13.1	-	1.8
Sesame	0.3	0.9	4.4	13.1	-	-
Rice	1.0	3.4	17.6	52.4	-	4.0
Melon	0.2	0.7	-	-	-	-
Water melon	0.2	0.7	-	-	-	-
Vegetables	0.1	1.5	-	-	-	0.2
Pasture	0.4	-	-	-	-	-
3. Gross Income ($ 10^3)	6.6	24.3	113.2	342.8	3,915.0	7.1
4. Production Cost ($ 10^3)						
4.1 Seed	0.1	0.3	1.3	3.8	33.0	0.2
4.2 Fertilizer	0.6	2.1	9.2	27.6	362.0	0.6
4.3 Chemical	0.7	2.6	10.1	32.0	55.0	0.6
4.4 Hired labor	-	1.7	12.8	37.3	777.0	0.9
4.5 Machinery cost	0.7	2.6	12.2	38.3	162.0	0.3
4.6 Transportation	0.3	0.9	6.5	17.5	689.0	0.1
4.7 Others	0.3	1.0	4.3	12.9	154.0	0.2
Total 4.1 to 4.7	2.7	11.2	56.4	169.4	2,232.0	2.9
5. Net Farm Income ($ 10^3): 3-4	3.9	13.1	56.8	173.4	1,683.0	4.2
6. Living Expense ($ 10^3)	1.2	1.2	5.4	6.4	-	1.2
7. Capacity-to-pay ($ 10^3); 5-6	2.7	11.9	51.4	167.0	1,683.0	3.0

Table 75 FARMERS' CAPACITY-TO-PAY IN THE PROJECT AREA AND ASSOCIATED IRRIGATION AREAS

	Description	No. of Household Nos.	Capacity-to-pay per Household $103	Amount $103
1.	Project Area			
	1.1 INA settler	1,294	2.7	3,494
	1.2 Less than 50 ha	169	11.9	2,011
	1.3 50 ha - 200 ha	34	51.4	1,748
	1.4 More than 200 ha	13	167.0	2,171
	1.5 Sugar cane estate	-	1,683.0	1,683
	Total 1.1 to 1.5	1,510		11,107
2.	Associated Irrigation Area	340	3.0	1,020
3.	Total 1. & 2.	1,850		12,127

Table 76 FINANCIAL COST AND BENEFIT STREAM

Unit : 10^6

	Year	Investment & O&M Costs			Project & Associated Benefits		
		Project	Associated	Total	Irrigation	Power	Total
1.	1978	2.06		2.06			
2.	1979	8.73		8.73			
3.	1980	13.57		13.57			
4.	1981	35.89		35.89			
5.	1982	23.48	6.38	29.86			
6.	1983	6.23	0.20	6.43	5.32	1.95	7.27
7.	1984	1.94	0.20	2.14	9.17	1.95	11.12
8.	1985	1.94	0.20	2.14	12.42	1.95	14.37
9.	1986	1.94	0.20	2.14	15.67	1.95	17.62
10.	1987	1.94	0.20	2.14	16.26	1.95	18.21
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
27.	2004	1.94	0.20	2.14	16.26	1.95	18.21

Table 77 FINANCIAL STATEMENT

Unit . 10^6

		Outgo				Income					Balance				
	Year	Investment & Replacement	O&M	Foreign Loan Repayment	Total	Foreign Loan	Farmers' Repayment	Water Charge	Energy Sales	Total	Outstanding Foreign Loan	Current Deficit	Current Surplus	Outstanding Deficit	Outstanding Surplus
1.	1978	2.06			2.06	1.84				1.84	1.89	0.22		0.22	
2.	1979	8.73			8.73	5.35				5.35	7.46	3.38		3.60	
3.	1980	13.57			13.57	9.17				9.17	17.24	4.40		8.00	
4.	1981	35.89			35.89	22.07				22.07	40.72	13.82		21.82	
5.	1982	23.48			23.48	16.28				16.28	59.44	7.20		29.02	
6.	1983	4.29	2.10	3.02	9.41	1.73	3.98	1.93	1.95	9.59	61.17		0.18	28.84	
7.	1984		2.14	3.06	5.20		5.00	1.97	1.95	8.92	61.17		3.72	25.12	
8.	1985		2.14	4.91	7.05		5.88	1.97	1.95	9.80	59.32		2.75	22.37	
9.	1986		2.14	4.91	7.05		6.10	1.97	1.95	10.02	57.38		2.97	19.40	
10.	1987		2.14	4.91	7.05		6.10	1.97	1.05	10.02	55.34		2.97	16.43	
11.	1988		2.14	4.91	7.05		6.10	1.97	1.95	10.02	53.20		2.97	13.46	
12.	1989		2.14	4.91	7.05		6.10	1.97	1.95	10.02	50.95		2.97	10.49	
13.	1990		2.14	4.91	7.05		6.10	1.97	1.95	10.02	48.59		2.97	7.52	
14.	1991		2.14	4.91	7.05		6.10	1.97	1.95	10.02	46.11		2.97	4.55	
15.	1992		2.14	4.91	7.05		6.10	1.97	1.95	10.02	43.51		2.97	1.58	
16.	1993		2.14	4.91	7.05		6.10	1.97	1.95	10.02	40.78		2.97		1.39
17.	1994		2.14	4.91	7.05		6.10	1.97	1.95	10.02	37.91		2.97		4.36
18.	1995		2.14	4.91	7.05		6.10	1.97	1.95	10.02	34.90		2.97		7.33
19.	1996		2.14	4.91	7.05		6.10	1.97	1.95	10.02	31.74		2.97		10.30
20.	1997		2.14	4.91	7.05		6.10	1.97	1.95	10.02	28.42		2.97		13.27
21.	1998		2.14	4.91	7.05		6.10	1.97	1.95	10.02	24.93		2.97		16.24
22.	1999		2.14	4.91	7.05		6.10	1.97	1.95	10.02	21.27		2.97		19.21
23.	2000		2.14	4.91	7.05		6.10	1.97	1.95	10.02	17.42		2.97		22.18
24.	2001		2.14	4.91	7.05		6.10	1.97	1.95	10.02	13.38		2.97		25.15
25.	2002		2.14	4.91	7.05		6.10	1.97	1.95	10.02	9.14		2.97		28.12
26.	2003		2.14	4.91	7.05		1.24	1.97	1.95	5.16	4.69	1.89			26.23
27.	2004		2.14	4.91	7.05			1.97	1.95	3.92	0	3.13			23.10
28.	2005		2.14		2.14			1.97	1.95	3.92			1.78		24.88
29.	2006	9.63	2.14		11.77			1.97	1.95	3.92		7.85			17.03
30.	2007		2.14		2.14			1.97	1.95	3.92			1.78		18.81

Table 78 FARMERS' BURDEN AT 1977 PRICE LEVEL

Description	10^6	$/ha
Water Charge	1.47	83
Farmers' share on capital	37.31	2,110
Annual repayment on the above	4.55	257

Remarks ; figures are for 17,680 net ha including 16,000 ha in the project area and 1,680 ha in the associated areas.

Table 79 FARMERS' CURRENT BALANCE

Unit : 10^3

	INA Settler	Less than 50 ha	50 ha-200 ha	More than 200 ha	Sugar cane estate	Associated areas
1. Average net ha	4.1	13.4	68.2	200.0	3,530.0	5.0
2. Capital share	8.7	28.3	143.9	422.1	7,449.3	10.6
3. Net farm income	3.9	13.1	56.8	173.4	1,683.0	4.2
4. Water charge	0.3	1.1	5.7	16.6	293.5	0.4
5. Loan repayment	1.1	3.4	17.6	51.5	908.8	1.3
6. Profit	2.5	8.6	33.5	105.3	480.7	2.5
7. Taxes	0	0.6	4.5	28.2	155.8	0
8. Living expense	1.2	1.2	5.4	6.4	-	1.2
9. Net surplus ; 6 - 7 - 8	1.3	6.8	23.6	70.7	324.9	1.3

Table 80 PRINCIPAL FEATURE OF FIRST STAGE DEVELOPMENT

1.	San Fernando Dam	
1.1	Reservoir	
	Gross storage capacity ;	145 x 10^6 m^3
	Active storage capacity ;	135 x 10^6 m^3
	Flood water surface ;	El. 814.5 m
	High water surface ;	El. 807.5 m
	Low water surface ;	El. 779.0 m
	Reservoir area ;	13.7 km^2
1.2	Dam & Spillway	
	Crest elevation ;	El. 815.0 m
	Crest length ;	170 m
	Dam height ;	79.5 m
	Dam volume ;	225.000 m^3
	River outlet ;	1.8 m dia Howell-Bunger valve
	Spillway discharge capacity;	3,300 m^3/s (routed PMF)
2.	Choluteca Plain Irrigation System	
2.1	Net Irrigable Area ;	12.400 ha
2.2	El Papalon Intake Weir: same as the final feature	
2.3	Canal & Road System	
	Main canals :	26.3 km
	Branch canals :	35.0 km
	Secondary canals :	69.3 km
	Main drain canals :	95.6 km
	Secondary drain canals ;	17.5 km
	Farm roads :	99.5 km
	On-farm construction ;	10.770 ha
	Reclamation ;	1.270 ha

Table 81 INCREASE IN AGRICULTURAL PRODUCTION UNDER WITH-PROJECT CONDITION OF THE FIRST STAGE DEVELOPMENT

	With-Project			Without-Project			
	Crop Area (ha)	Unit Yield (ton/ha)	Production (ton)	Crop Area (ha)	Unit Yield (ton/ha)	Production (ton)	Production Increase (ton)
Sugar cane							
- estate farm	3,530	118.3	417,600	3,400	78.6	267,200	150,400
- outgrowers' farm	1,640	118.3	194,000	1,540	70.0	107,800	86,200
- expanded outgrowers' farm	1,590	118.3	188,100	5,100	61.4	313,100	-125,000
Sub-total	6,760		799,700	10,040		688,100	111,600
Maize							
- mechanized	3,200	4.0	12,800	-	-	-	12,800
- semi-mechanized	-	-	-	990	2.0	2,000	-2,000
- traditional	-	-	-	330	1.6	500	-500
Sub-total	3,200		12,800	1,320		2,500	10,300
Sorghum							
- mechanized	400	4.0	1,600	-	-	-	1,600
- semi - mechanized	-	-	-	80	2.0	200	-200
- traditional	-	-	-	90	1.6	100	-100
Sub-total	400		1,600	170		300	1,300
Beans	400	2.0	800	-	-	-	800
Cotton	3,000	3.0	9,000	740	2.0	1,500	7,500
Sesame	400	1.5	600	110	1.3	100	500
Rice							
- wet season	900	5.0	4,500	100	3.0	300	4,200
- dry season	900	5.0	4,500	-	-	-	4,500
Sub-total	1,800		9,000	100		300	8,700
Melon	300	6.5	2,000	260	5.2	1,400	600
Water melon	300	12.0	3,600	210	8.0	1,700	1,900
Vegetable	400	20.0	8,000	-	-	-	8,000
Livestock	140			1,990			
- Milk	(140)	190 ℓ	30kℓ	(1,990)	190 ℓ	380 kℓ	-350 kℓ
- Meat	(140)	130 kg	20	(1,990)	130 kg	260	-240
	17,100			14,940			

Remarks: Rice: 9,000 paddy tons = 5,400 polished tons

Table 82 INVESTMENT DISBURSEMENT SCHEDULE OF THE FIRST STAGE DEVELOPMENT

(Unit : 10^6)

	1978	1979	1980	1981	1982	1983	Total
1. San Fernando Dam & Power Station							
1.1 Access road & quarter		1.23	0.41				1.64
1.2 Diversion & coffering			0.64				0.64
1.3 Dam & spillway		1.01	3.65	8.50	4.32		17.48
1.4 Intake, penstock & outlet		0.05	0.03	0.08	0.13		0.29
1.5 Powerhouse & tailrace							-
1.6 Generating equipment							-
1.7 Transmission line & substation							-
1.8 Highway relocation				0.91	0.41		1.32
Sub-total		2.29	4.73	9.49	4.86		21.37
2. Choluteca Plain Irrigation System							
2.1 Communication system & quarter		0.56	0.32				0.88
2.2 El Papalón intake weir			1.03	1.29	1.28		3.60
2.3 Main canal system			0.28	2.88	2.82		5.98
2.4 Branch canal system			0.19	1.75			1.94
2.5 Secondary canal system			0.07	0.71	0.50		1.28
2.6 Drainage canal system			0.14	1.26	0.31		1.71
2.7 Farm road system			0.06	0.53	0.23		0.82
2.8 On-farm construction			0.14	1.29	0.45		1.88
2.9 Clearing & reclamation			0.11	1.05	0.43		1.59
Sub-total		0.56	2.34	10.76	6.02		19.68
3. Engineering & Administration	1.31	2.29	1.00	0.99	0.99	0.02	6.60
4. Land Compensation		0.08	0.24	0.26	0.04		0.62
Total 1 to 4	1.31	5.22	8.31	21.50	11.91	0.02	48.27
5. Physical Contingency (10%)	0.14	0.52	0.83	2.15	1.19	0.0	4.83
6. Price Contingency (5%/year)	0.07	0.58	1.44	5.09	3.62	0.01	10.81
Total 1 to 6	1.52	6.32	10.58	28.74	16.72	0.03	63.91

Table 83 INVESTMENT DISBURSEMENT SCHEDULE
FOREIGN CURRENCY COMPONENT
OF THE FIRST STAGE DEVELOPMENT

(Unit : 10^6)

	1978	1979	1980	1981	1982	1983	Total
1. San Fernando Dam & Power Station							
1.1 Access road & quarter		-	-				-
1.2 Diversion & coffering			0.49				0.49
1.3 Dam & spillway		0.71	2.57	6.00	3.05		12.33
1.4 Intake, penstock & outlet		0.05	0.03	0.07	0.11		0.26
1.5 Powerhouse & tailrace							-
1.6 Generating equipment							-
1.7 Transmission line & substation							-
1.8 Highway relocation				0.18	0.08		0.26
Sub-total		0.76	3.09	6.25	3.24		13.34
2. Choluteca Plain Irrigation System							
2.1 Communication system & quarter		0.20	0.20				0.40
2.2 El Papalón intake weir			0.83	1.00	1.00		2.83
2.3 Main canal system			0.14	1.43	1.41		2.98
2.4 Branch canal system			0.14	1.26			1.40
2.5 Secondary canal system			0.05	0.52	0.37		0.94
2.6 Drainage canal system			0.09	0.85	0.21		1.15
2.7 Farm road system			0.04	0.35	0.17		0.56
2.8 On-farm construction							-
2.9 Clearing & reclamation							-
Sub-total		0.20	1.49	5.41	3.16		10.26
3. Engineering & Administration	1.16	1.82	0.94	0.93	0.93	0.02	5.80
4. Land Compensation							-
Total 1 to 4	1.16	2.78	5.52	12.59	7.33	0.02	29.40
5. Physical Contingency (10%)	0.12	0.28	0.55	1.26	0.73	0	2.94
6. Price Contingency (5%/year)	0.06	0.31	0.96	2.98	2.23	0.01	6.55
Total 1 to 6	1.34	3.37	7.03	16.83	10.29	0.03	38.89

Table 84 INVESTMENT DISBURSEMENT SCHEDULE
LOCAL CURRENCY COMPONENT
OF THE FIRST STAGE DEVELOPMENT

(Unit : 10^6)

	1978	1979	1980	1981	1982	1983	Total
1. San Fernando Dam & Power Station							
1.1 Access road & quarter		1.23	0.41				1.64
1.2 Diversion & coffering			0.15				0.15
1.3 Dam & spillway		0.30	1.08	2.50	1.27		5.15
1.4 Intake, penstock & outlet				0.01	0.02		0.03
1.5 Powerhouse & tailrace							-
1.6 Generating equipment							-
1.7 Transmission line & substation							-
1.8 Highway relocation				0.73	0.33		1.06
Sub-total		1.53	1.64	3.24	1.62		8.03
2. Choluteca Plain Irrigation System							
2.1 Communication system & quarter		0.36	0.12				0.48
2.2 El Papalón intake weir			0.20	0.29	0.28		0.77
2.3 Main canal system			0.14	1.45	1.41		3.00
2.4 Branch Canal system			0.05	0.49			0.54
2.5 Secondary canal system			0.02	0.19	0.13		0.34
2.6 Drainage canal system			0.05	0.41	0.10		0.56
2.7 Farm road system			0.02	0.18	0.06		0.26
2.8 On-farm construction			0.14	1.29	0.45		1.88
2.9 Clearing & reclamation			0.11	1.05	0.43		1.59
Sub-total		0.36	0.85	5.35	2.86		9.42
3. Engineering & Administration	0.15	0.47	0.06	0.06	0.06		0.80
4. Land Compensation		0.08	0.24	0.26	0.04		0.62
Total 1 to 4	0.15	2.44	2.79	8.91	4.58		18.87
5. Physical Contingency (10%)	0.02	0.24	0.28	0.89	0.46		1.89
6. Price Contingency (5%/year)	0.01	0.27	0.48	2.11	1.39		4.26
Total 1 to 6	0.18	2.95	3.55	11.91	6.43		25.02

Table 85 REPLACEMENT COST OF THE FIRST STAGE DEVELOPMENT

	Amount (10^3)
1. San Fernando Dam	
- Spillway gate	792
- Outlet valve	150
Sub-total	942
2. Choluteca Plain Irrigation System	
- Gate & trashrack : Intake wire	253
- Gate & trashrack : Main canal	323
- Gate & trashrack : Branch canal	181
- Gate & trashrack : Secondary canal	165
Sub-total	922
3. Physical Contingency	186
Total	2,050
4. Less : Salvage Value (10^3)	210
5. Replacement Cost	1,840

Table 86 O&M COST OF THE FIRST STAGE DEVELOPMENT

	Amount (10^3)
1. San Fernando Dam	
1.1 Personnel cost	70
1.2 Maintenance and repairing cost	50
Sub-total	120
2. Choluteca Plain Irrigation System	
2.1 Operation and maintenance of irrigation facilities	570
2.2 Extension and training services	120
2.3 Administration	160
Sub-total	850
3. Physical Contingency (10% of the above 1. and 2.)	100
Total	1,070

Table 87 PROJECT IRRIGATION BENEFIT OF THE FIRST STAGE DEVELOPMENT

Description	With-Project			Without-Project			
	Crop Area (ha)	Unit Value ($)	Amount ($10^3)	Crop Area (ha)	Unit Value ($)	Amount ($10^3)	Benefit ($10^3)
Sugar cane							
- estate farm	3,530	813	2,870	3,400	361	1,227	1,643
- outgrowers' farm	1,640	813	1,333	1,540	376	579	754
- expanded outgowers' farm	1,590	813	1,293	5,100	295	1,505	-212
Sub-total	6,760		5,496	10,040		3,311	2,185
Maize							
- mechanized	3,200	359	1,149	-	-	-	1,149
- semi-mechanized	-	-	-	990	132	131	-131
- traditional	-	-	-	330	111	37	-37
Sub-total	3,200		1,149	1,320		168	981
Sorghum							
- mechanized	400	321	128	-	-	-	128
- semi-mechanized	-	-	-	80	132	11	-11
- traditional	-	-	-	90	97	9	-9
Sub-total	400		128	170		20	108
Beans	400	249	100	-	-	-	100
Cotton	3,000	657	1,971	740	196	145	1,826
Sesame	400	287	115	110	174	19	96
Rice							
- wet season	900	510	459	100	111	11	448
- dry season	900	508	457	-	-	-	457
Sub-total	1,800		916	100		11	905
Melon	300	541	162	260	263	68	94
Water melon	300	323	97	210	103	22	75
Vegetable	400	752	301	-	-	-	301
Livestock	140	77	11	1,990	77	153	-142
Total	17,100		10,446	14,940		3,917	6,529

Table 88 PRODUCTION FORGONE IN THE RESERVOIR AREA OF THE FIRST STAGE DEVELOPMENT

Description	Crop Area (ha)	Unit Value ($/ha)	Amount (10^3)
Maize	240	111	27
Sorghum	60	97	6
Pasture	300	77	23
Forest	800	40	32
Total	1,400		88

Table 89 BENEFIT EXPECTED FROM ASSOCIATED FACILITIES IN THE FIRST STAGE DEVELOPMENT

(unit : 10^3)

	With-Project			Without-Project			
	Crop Area (ha)	Unit Value ($)	Amount (10^3)	Crop Area (ha)	Unit Value ($)	Amount (10^3)	Benefit (10^3)
San Juan de Flores (A&B)							
Sugar cane	340	813	276	110	376	41	235
Maize	-	-	-	180	111	20	-20
Livestock	-	-	-	70	77	5	-5
			276			66	210

Table 90 ECONOMIC BENEFIT STREAM OF THE FIRST STAGE DEVELOPMENT

(Unit : 10^6)

Year in Order	Year	Project Irrigation	Associated Irrigation	Production Forgone	Total
1	1978	-	-	-	-
2	1979	-	-	-	-
3	1980	-	-	-	-
4	1981	-	-	-	-
5	1982	-	-	-0.04	-0.04
6	1983	2.61	0.08	-0.07	2.62
7	1984	3.92	0.13	-0.07	3.98
8	1985	5.22	0.17	-0.07	5.32
9	1986	6.53	0.21	-0.07	6.67
10	1987	6.53	0.21	-0.07	6.67
⋮	⋮	⋮	⋮	⋮	⋮
28	2005	6.53	0.21	-0.07	6.67
29	2006	6.53	0.21	-0.07	6.67
30	2007	6.53	0.21	-0.07	6.67
⋮	⋮	⋮	⋮	⋮	⋮
50	2027	6.53	0.21	-0.07	6.67

Table 91 ECONOMIC INVESTMENT DISBURSEMENT SCHEDULE OF THE FIRST STAGE DEVELOPMENT

(Unit : 10^6)

	1978	1979	1980	1981	1982	1983	Total
1. San Fernando Dam	-	2.06	4.26	8.54	4.37	-	19.23
2. Choluteca Plain Irrigation System	-	0.50	2.11	9.67	5.42	-	17.70
3. Engineering and Administration	1.29	2.24	0.98	0.97	0.97	0.02	6.47
Sub-total	1.29	4.80	7.35	19.18	10.76	0.02	43.40
4. Physical Contingency (10%)	0.13	0.48	0.74	1.91	1.08	-	4.34
Total	1.42	5.28	8.09	21.09	11.84	0.02	47.74

Table 92 ASSOCIATED FACILITIES COST OF THE FIRST STAGE DEVELOPMENT

(Unit : 10^3)

1. Preparation work including acce-s road, office building	25
2. Pumping station	384
3. Irrigation, drainage and road system	87
4. Reclamation & on-farm facilities	57
5. Engineering & administration	86
6. Physical contingency	65
7. Total 1 to 6	704
8. Less transfer payment (15%)	106
9. Economic investment cost	598
10. Replacement cost	300
11. O&M cost	30

Table 93 ECONOMIC COST STREAM OF THE FIRST STAGE DEVELOPMENT

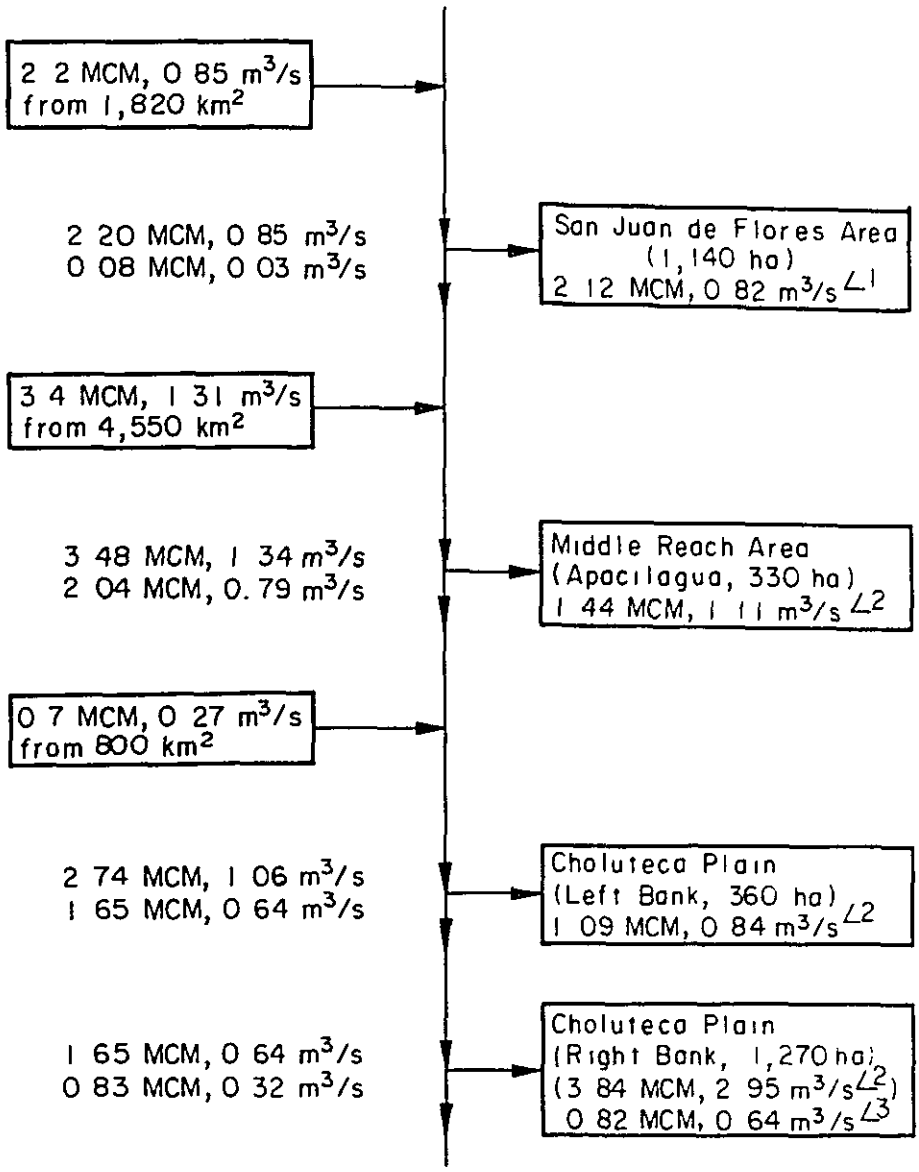
(Unit: 10^6)

Year in Order	Year	Investment & Replacement		O & M		Total
		Project Facilities	Associated Facilities	Project Facilities	Associated Facilities	
1	1978	1.42	-	-	-	1.42
2	1979	5.28	-	-	-	5.28
3	1980	8.09	-	-	-	8.09
4	1981	21.09	-	-	-	21.09
5	1982	11.84	0.60	-	-	12.44
6	1983	0.02	-	0.96	0.03	1.01
7	1984	-	-	0.96	0.03	0.99
8	1985	-	-	0.96	0.03	0.99
9	1986	-	-	0.96	0.03	0.99
10	1987	-	-	0.96	0.03	0.99
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
28	2005	-	-	0.96	0.03	0.99
29	2006	1.66	0.30	0.96	0.03	2.95
30	2007	-	-	0.96	0.03	0.99
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
50	2027	-	-	0.96	0.03	0.99

Table 94 SENSITIVITY TEST OF THE FIRST STAGE DEVELOPMENT

		EIRR (%)
A.	As scheduled	9.1
B.	Benefit 10% reduction	8.0
C.	Cost 20% increase	7.3
D.	Benefit 1 - year delay	8.3
E.	B + C	6.5
F.	B + D	7.4
G.	C + D	6.8
H.	B + C + D	6.0

Fig. 1 WATER BALANCE IN APRIL UNDER PRESENT SITUATION



/1 . Gravity intake requirement, 24-hour operation

/2 Pump intake requirement, 12-hour operation

/3 Maximum intake due to water shortage

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Fig.-2 SCHEMATIC CANAL LAYOUT OF CHOLUTECA COASTAL PLAIN AREA

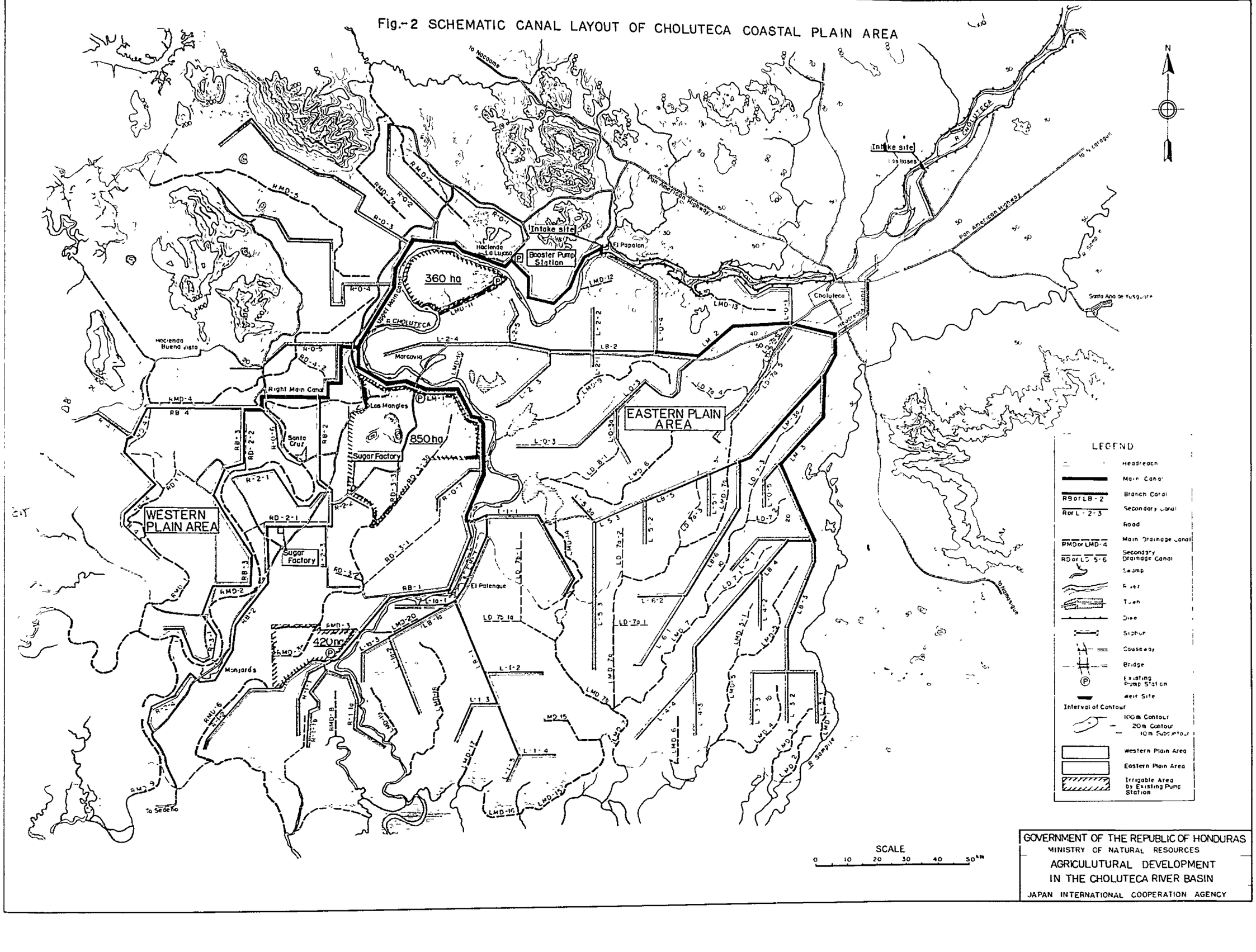

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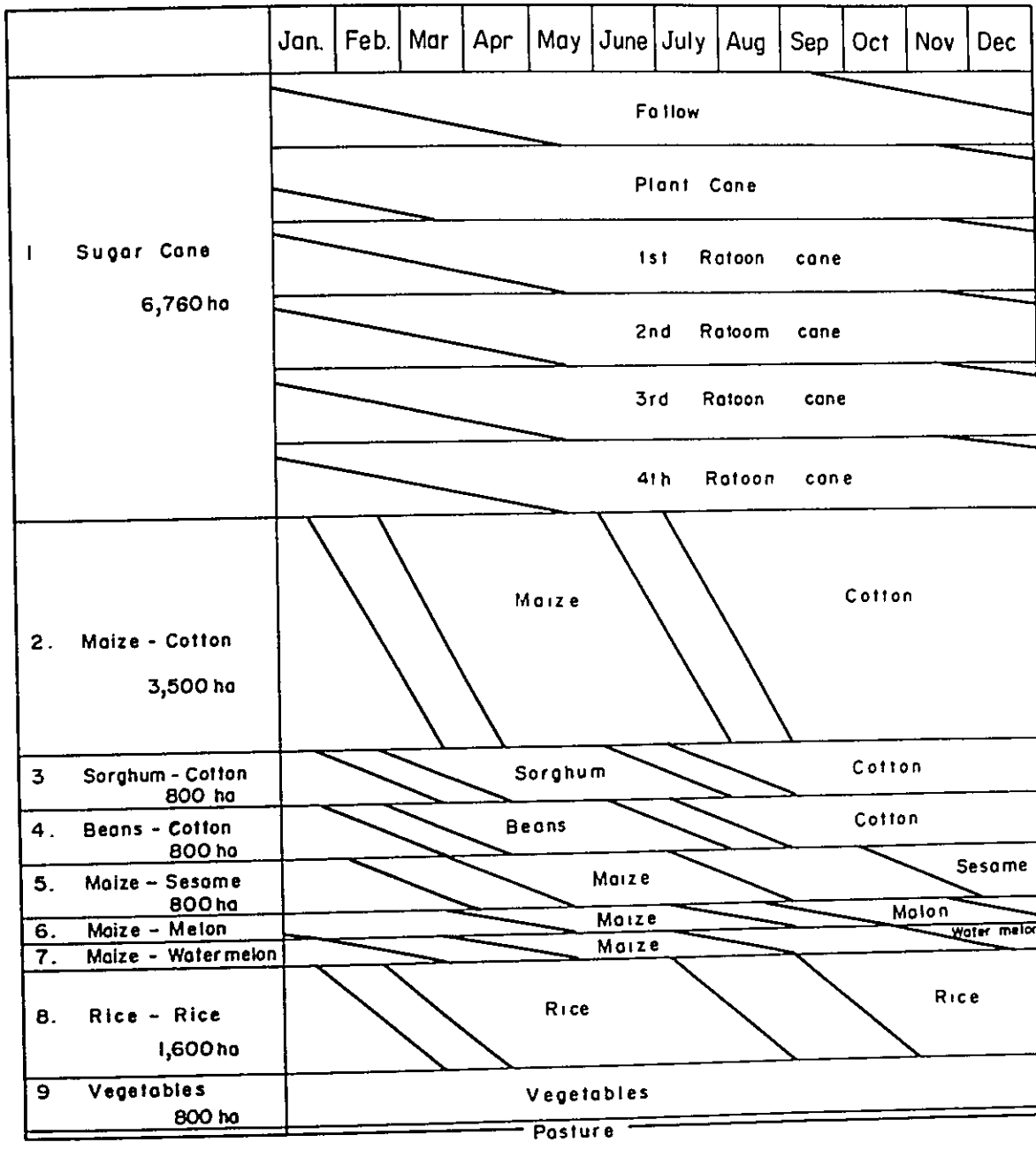
Fig. 3 PROPOSED CROPPING PATTERN (CHOLUTECA WESTERN PLAIN)



6.	Maize - Melon	400 ha
7.	Maize - Water melon	400 ha
10.	Pasture	140 ha

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Fig. 4 RESERVOIR OPERATION STUDY

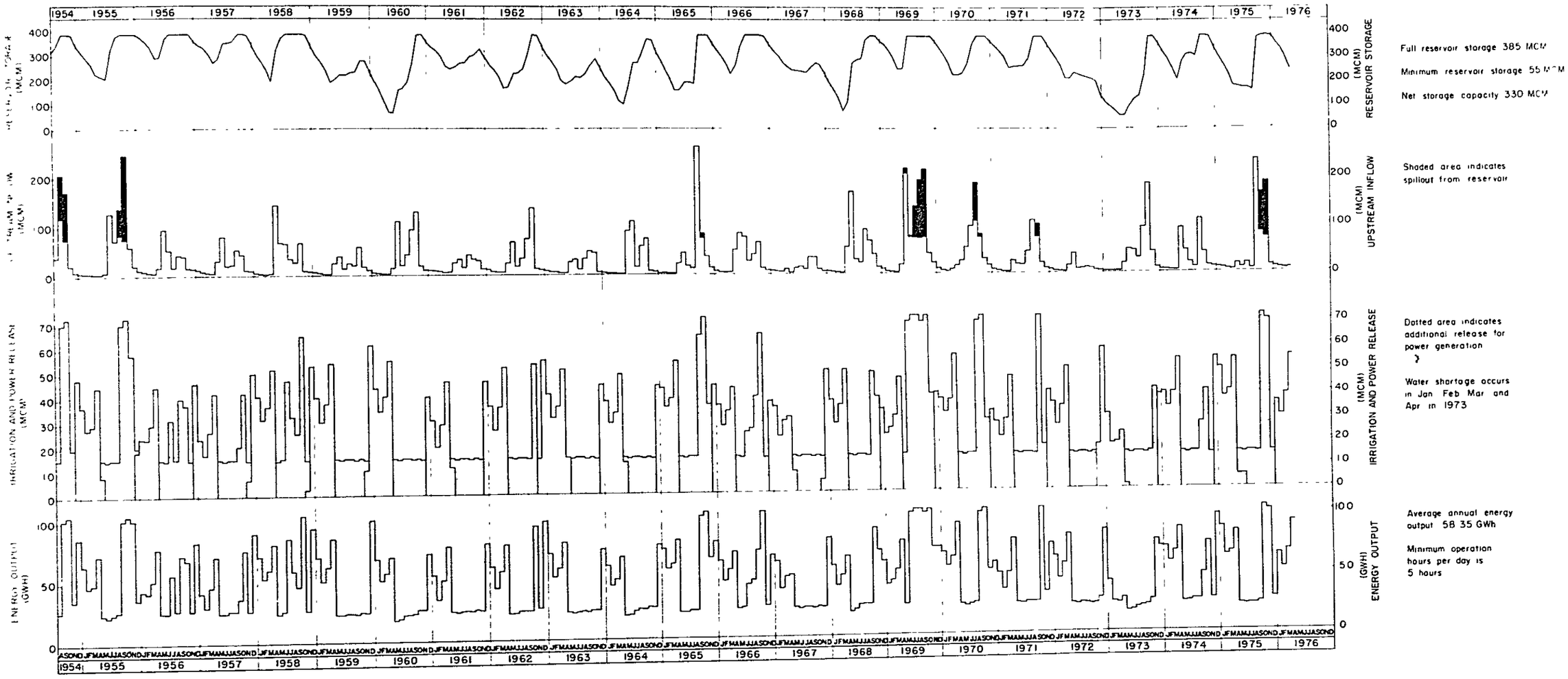

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Fig. 5 PROPOSED CONSTRUCTION SCHEDULE OF THE PROJECT

Description	Quantity
Administration & Engineering	
1 1 Feasibility study	
1 2 Loan arrangement	
1 3 Selection of consultant	
4 Detailed engineering & construction supervision	
1 5 Land acquisition	
Access Road & Quarter for Dam Construction	
2 1 Tender & Contract	
2 Construction	
San Fernando Dam & Power Station	
3 1 Tender & contract	
3 2 Mobilization & preparatory work	
3 3 Diversion & coffering work	ø36m x 310m
3 4 Dam foundation excavation	150,000 m³
3 5 Dam & spillway concreting	350,000 m³
3 6 Power house	
Penstock & Intake Gate	
4 1 Tender & contract	
4 2 Manufacturing & delivery	
4 3 Installation	
Spillway Gate	
5 1 Tender & contract	
5 2 Manufacturing & delivery	
5 3 Installation	
Generating Equipment & Outlet Valve	
6 1 Tender & contract	
6 2 Manufacturing & delivery	
6 3 Installation	
Transmission Line & Substation	25 km
1 Tender & contract	
7 2 Manufacturing & delivery	
7 3 Installation	
Relocation of Highway	8 km
8 Tender & contract	
8 2 Construction	
Buildings & Quarters in Choluteca Plain	
9 Tender & contract	
9 2 Construction	
Telecommunication System	
10 Tender & contract	
10 2 Manufacturing, delivery & installation	
11 Papalon Intake Weir	
11 1 Tender & contract	
11 2 Mobilization & preparatory work	
11 3 Coffering	
11 4 Concreting	15,000 m³
Irrigation, Drainage & Road System in Division 1	3,300ha
12 1 Tender & contract	
12 2 Irrigation canals & roads	43 km
12 3 Drainage canals	18 km
12 4 Related structures	
Irrigation, Drainage & Road Systems in Division 2	9,100 ha
13 Tender & contract	
13 2 Irrigation canals & roads	87 km
13 3 Drainage canals	72 km
13 4 Related structures	
Irrigation, Drainage & Road Systems in Division 3	3,600 ha
14 1 Tender & contract	
14 2 Irrigation canals & roads	27 km
14 3 Drainage canals	29 km
14 4 Related structures	
15 Reclamation & On-farm Construction	
15 1 Tender & contract for Division 1	
15 2 Construction for Division 1	2,900 ha
15 3 Tender & contract for Division 2	
15 4 Construction for Division 2	7,800 ha
15 5 Tender & contract for Division 3	
15 6 Construction for Division 3	3,600 ha

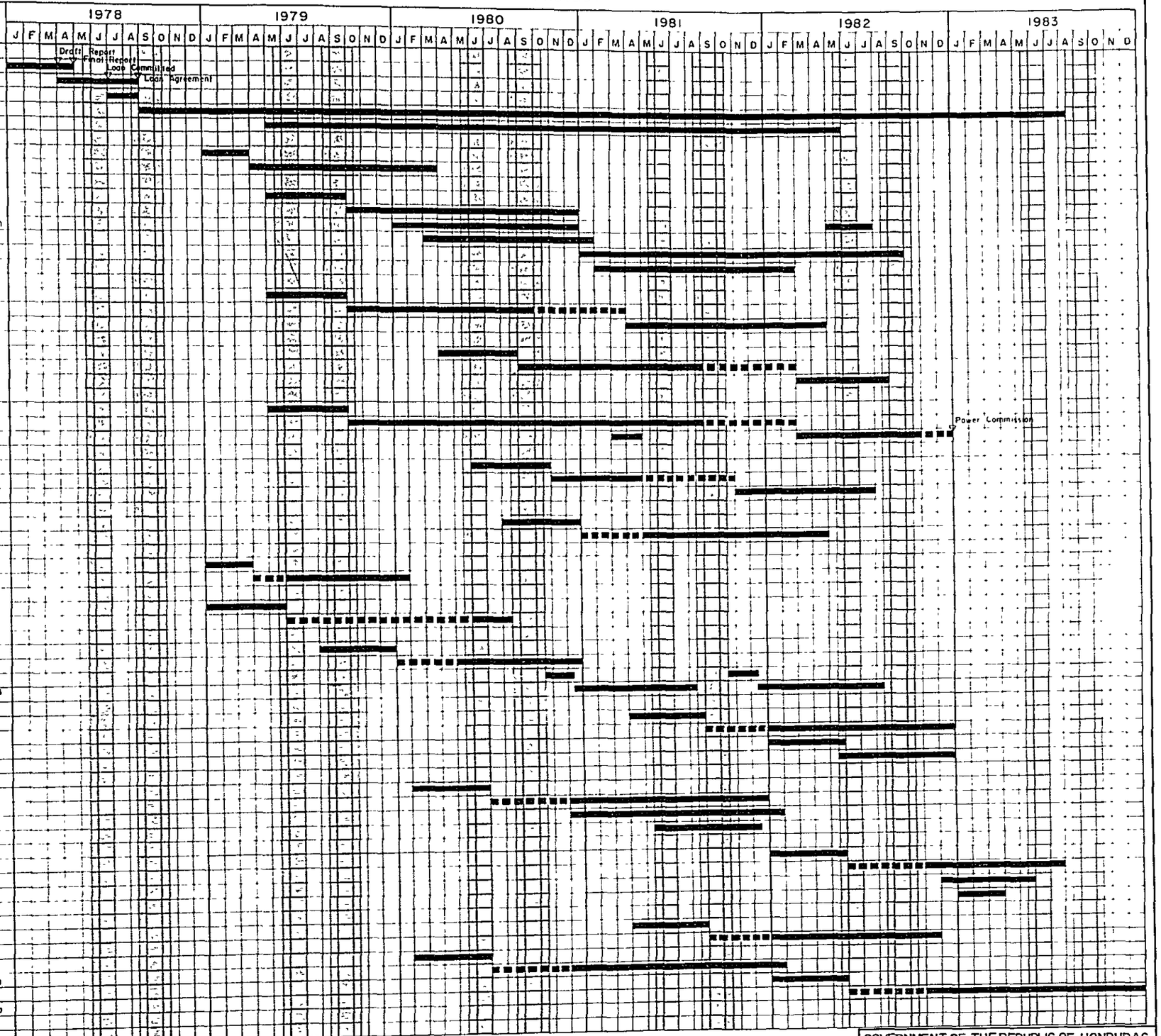

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Fig 6 ORGANIZATION CHART DURING CONSTRUCTION

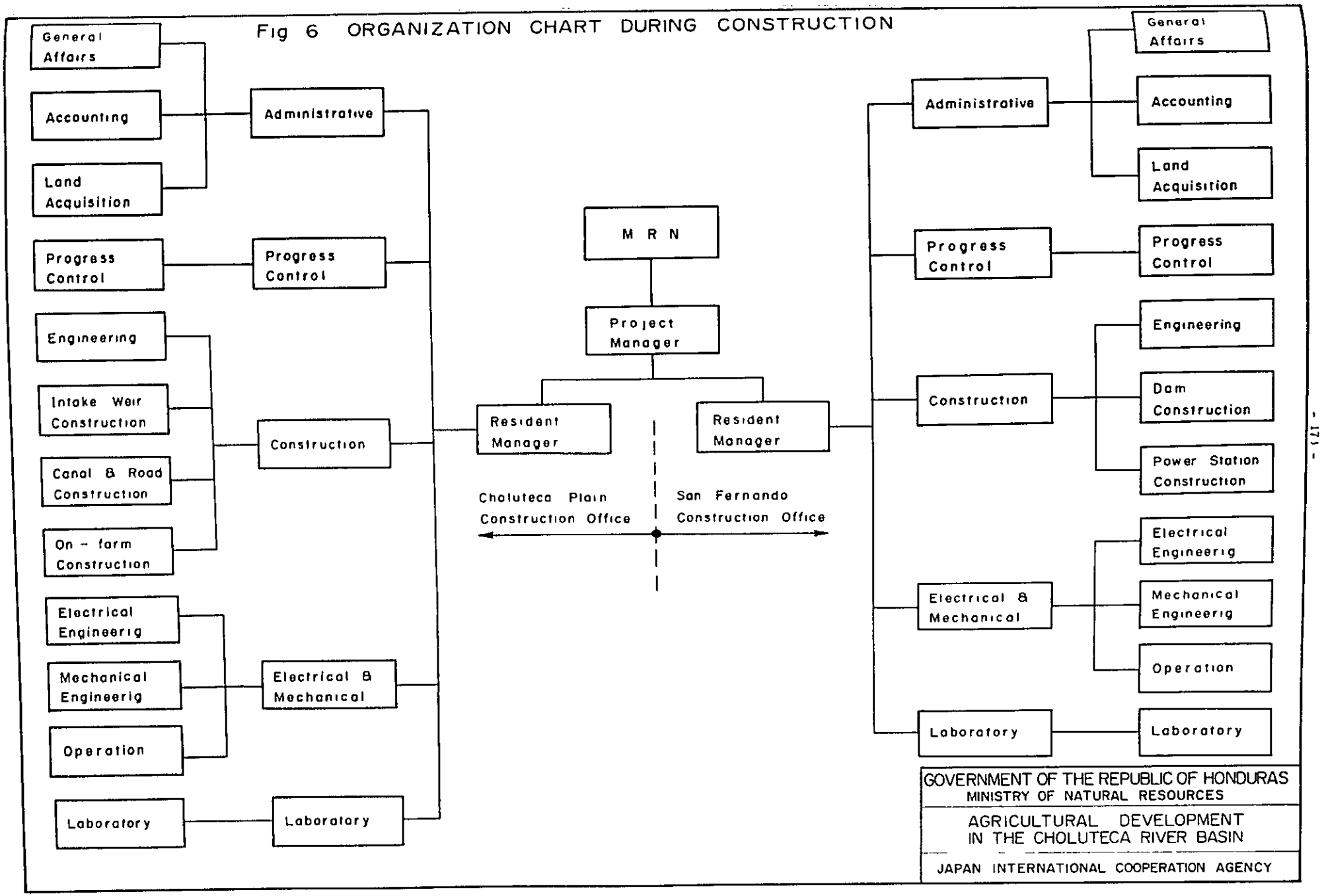

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Fig. 7 ORGANIZATION CHART OF SAN FERNANDO MANAGEMENT OFFICE

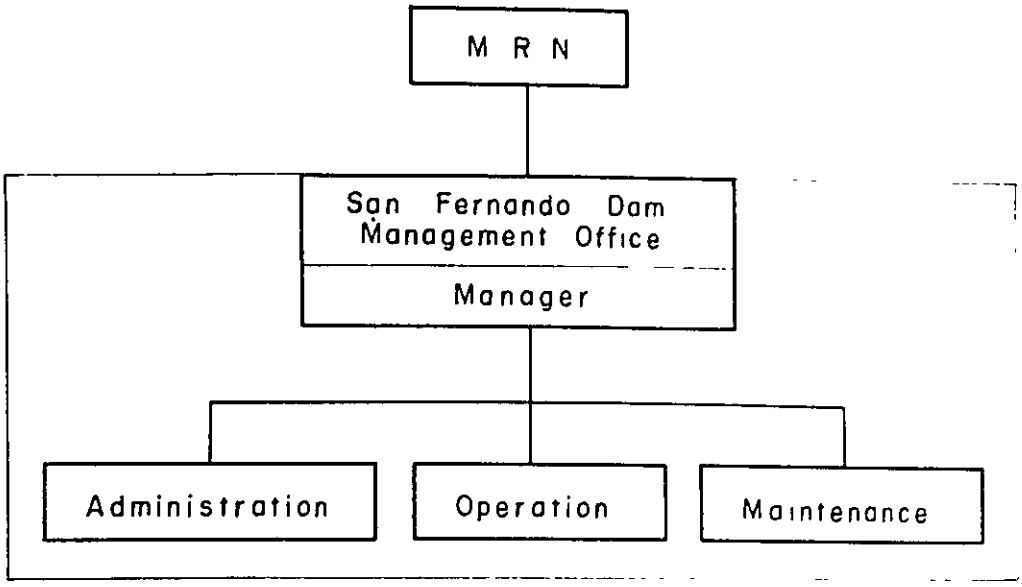

Fig. 8 ORGANIZATION CHART OF CHOLUTECA WATER MANAGEMENT OFFICE

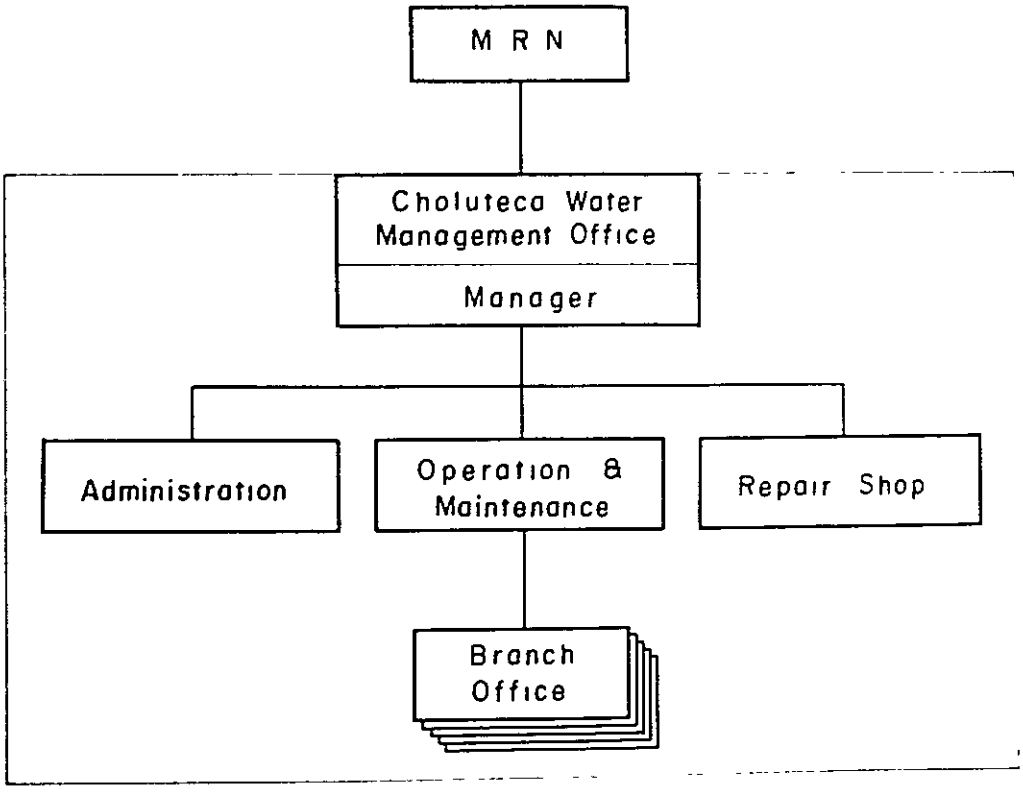

Fig. 9 BENEFIT – COST CURVES

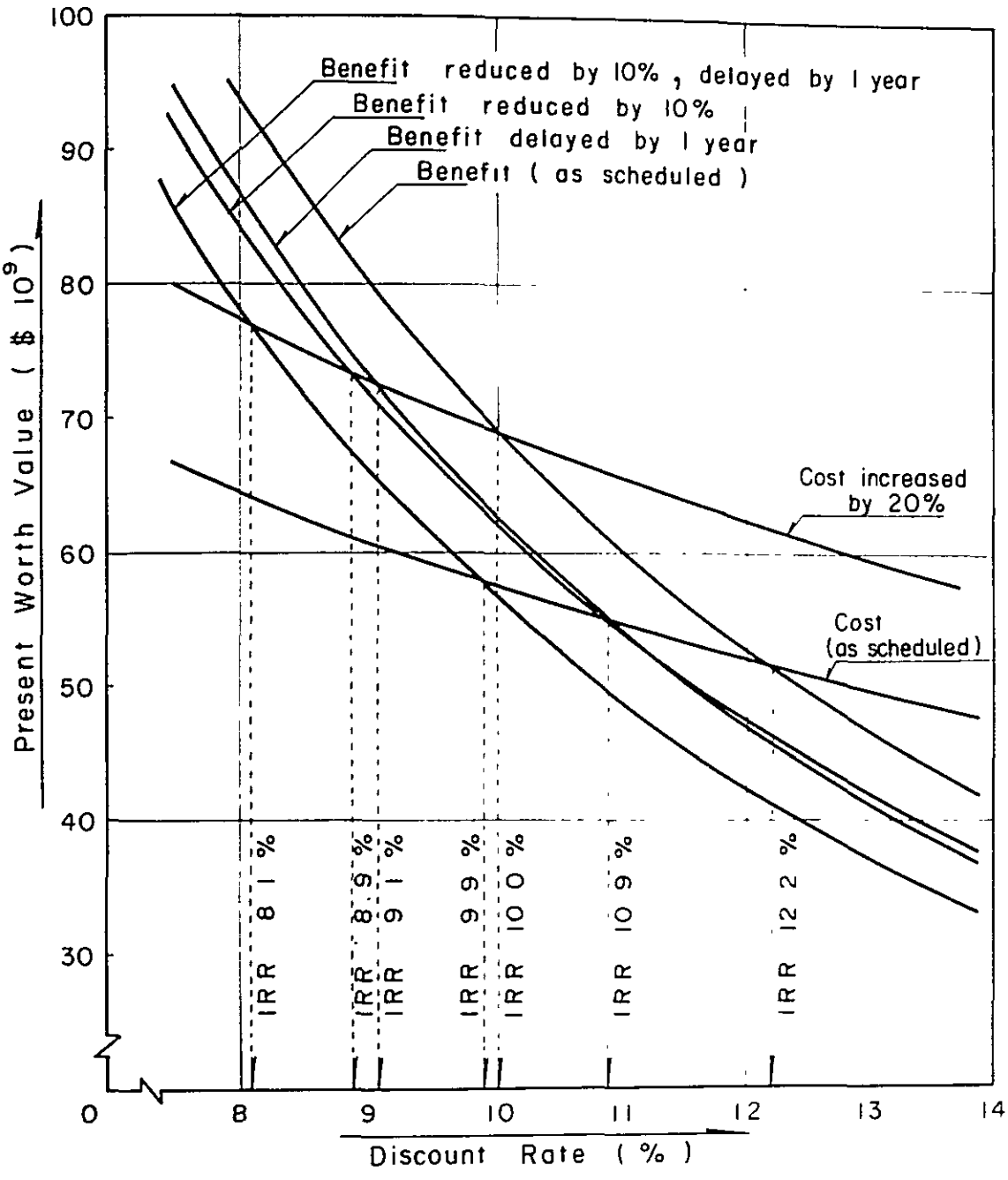

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Fig. 10 BENEFIT - COST CURVES OF THE FIRST STAGE DEVELOPMENT

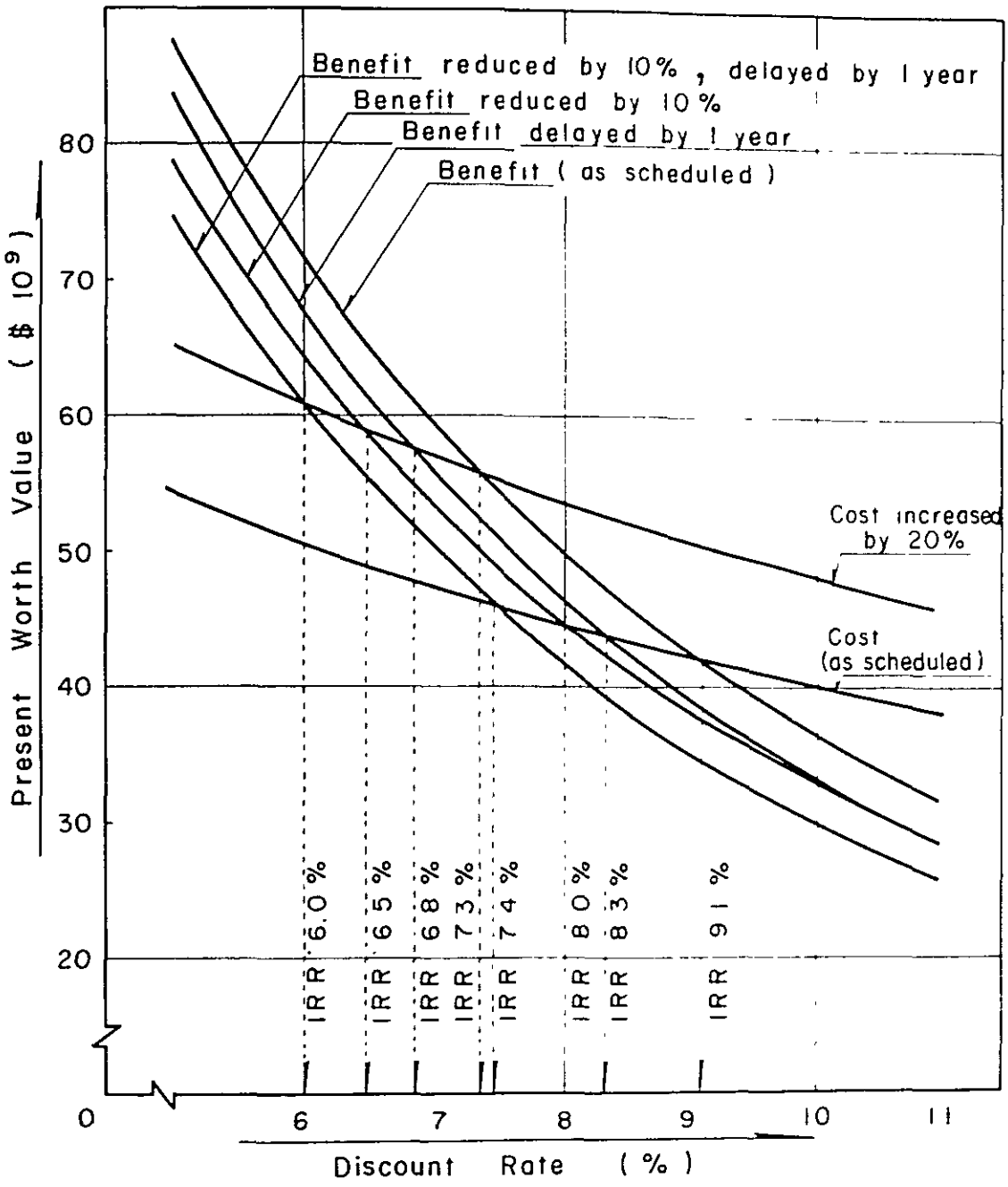

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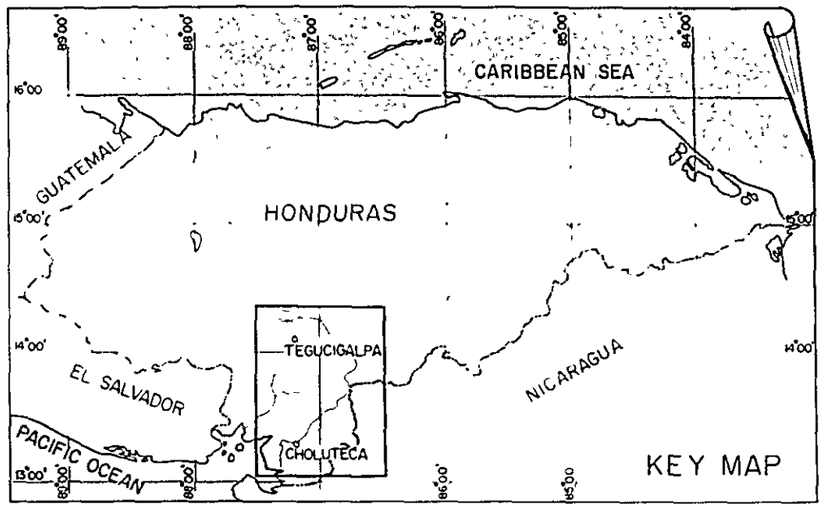
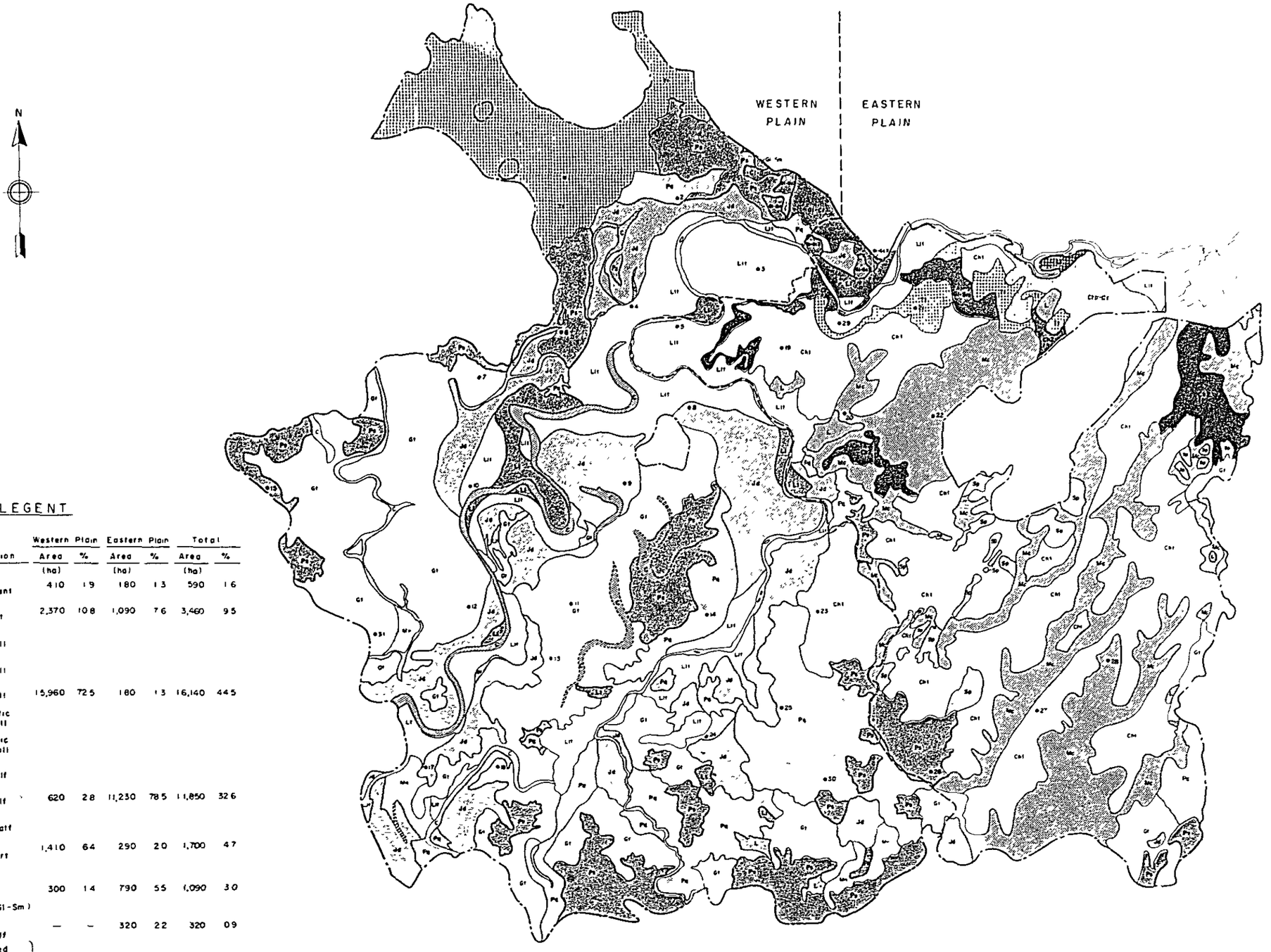
PLATE NO 1



GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES	TITLE OF DRAWING LOCATION MAP
AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	DWG. NO 00001 JAPAN INTERNATIONAL COOPERATION AGENCY

PLATE NO 2



LEGENT

Mapping Symbol		Soil Classification	Western Plain Area (ha)	%	Eastern Plain Area (ha)	%	Total Area (ha)	%
	(Lit)	Typic Ustifluvent	410	1 9	180	1 3	590	1 6
	(L I)	Fluventic Ustropept	2,370	10 8	1,090	7 6	3,460	9 5
	(Jd)	Fluventic Haplustoll						
	(Gt)	Aquic Haplustoll						
	(Mn)	Fluventic Haplustoll	15,960	72 5	180	1 3	16,140	44 5
	(Pq)	Fluvaquentic Haplustoll						
	(Ps)	Fluvaquentic Haplaquoll						
	(Ch1)	Aquic Haplustalf						
	(Ch2)	Aquic Haplustalf	620	2 8	11,230	78 5	11,850	32 6
	(Mc)	Vertic Tropaqualf						
	(Tr)	Typic Pellustert	1,410	6 4	290	2 0	1,700	4 7
		Udic Haplustalf (Chp - Cr)	300	1 4	790	5 5	1,090	3 0
		Udic Haplustalf (Gl-Cr, Gl-Gcs, Gl-Sm)						
	(Sp)	Udic Paleustalf	—	—	320	2 2	320	0 9
		Pond, river bed (C, L)	930	4 2	220	1 6	1,150	3 2
		Water						
Total			22,000	100 0	14,300	100 0	36,300	100 0

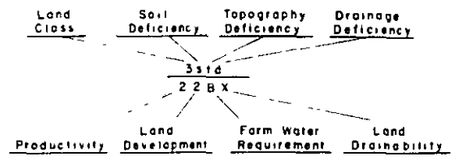
Remarks, ● No 1 - 31 Location of Pits

SCALE 0 1 2 3 4 5 km

GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	TITLE OF DRAWING SOIL MAP OF CHOLUTECA PLAIN DWG NO 1101 JAPAN INTERNATIONAL COOPERATION AGENCY

PLATE NO 3

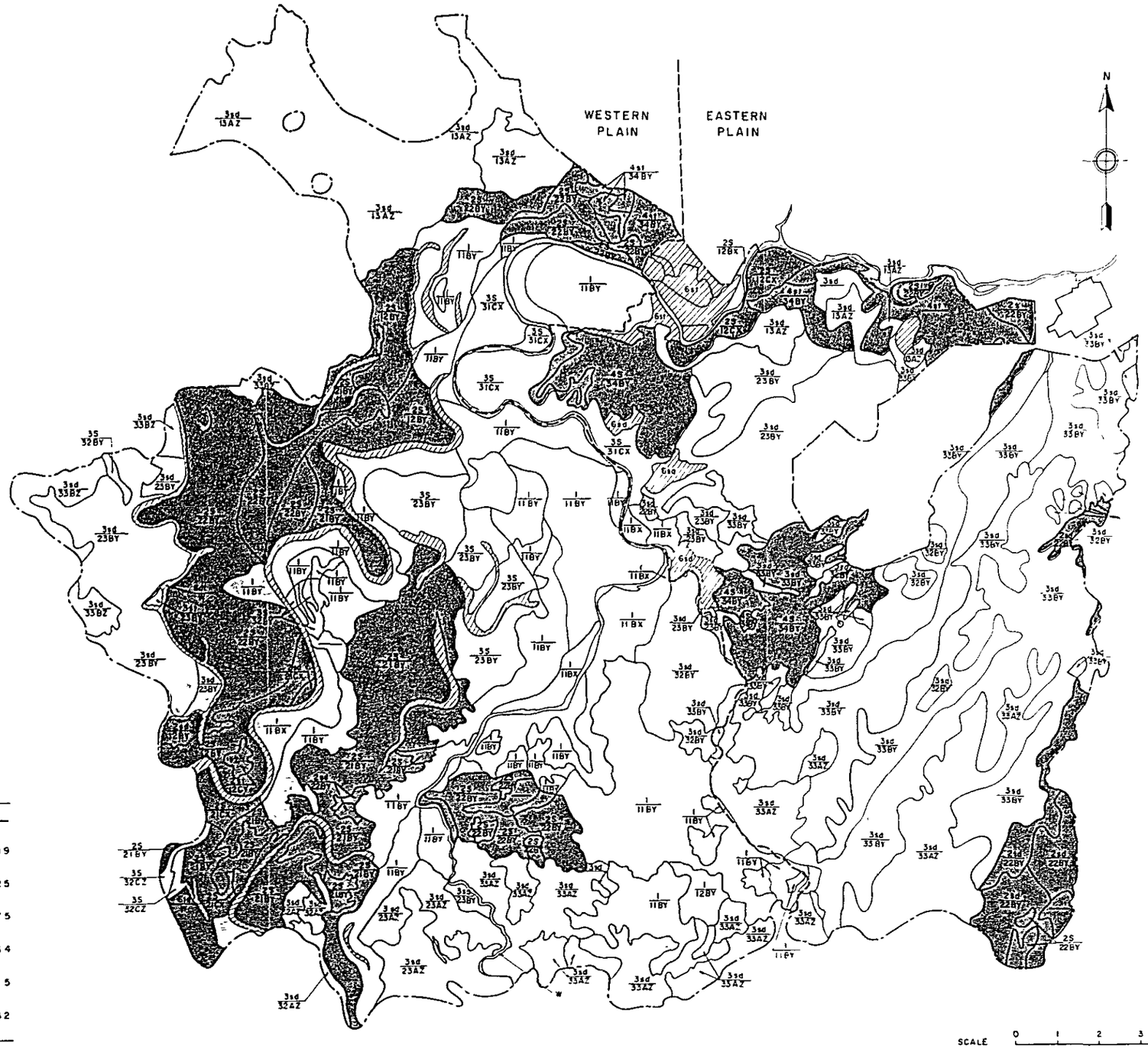
EXSAMPLE OF STANDARD MAPPING SYMBOL



Productivity and Development 1,2,3,4 or 6 denoting land class level factor, such as class 2 productivity, class 2 development cost - "22"

Farm Water Requirement A - Low, B - Medium, C - High

Land Drainability X - Good, Y - Restrict, C - Poor or negligible

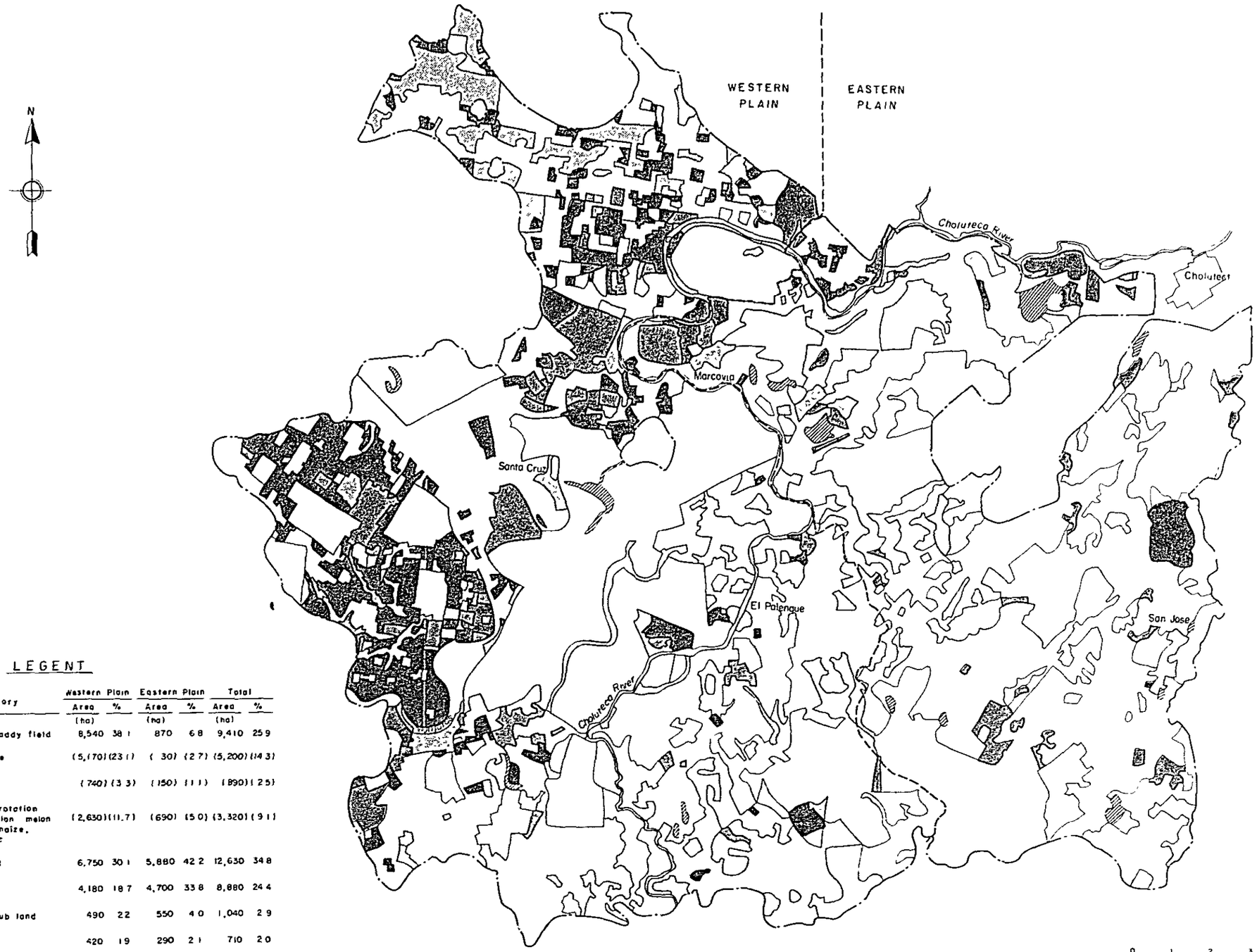


LEGEND

Mapping Symbol	Land Classification	Western Plain ha	%	Eastern Plain ha	%	Total ha	%
	Class I	6,400	29 1	450	3 1	6,850	18 9
	Class II	6,750	30 7	1,420	9 9	8,170	22 5
	Class III	7,530	34 2	9,710	68 0	17,240	47 5
	Class IV	130	0 6	2,200	15 4	2,330	6 4
	Class VI	260	1 2	300	2 1	560	1 5
	Water	930	4 2	220	1 5	1,150	3 2
	Total	22,000	100 0	14,300	100 0	36,300	100 0

GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES	TITLE OF DRAWING LAND CAPABILITY MAP OF CHOLUTECA PLAIN
AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	DWG NO 1103 JAPAN INTERNATIONAL COOPERATION AGENCY

PLATE NO 4



LEGENT

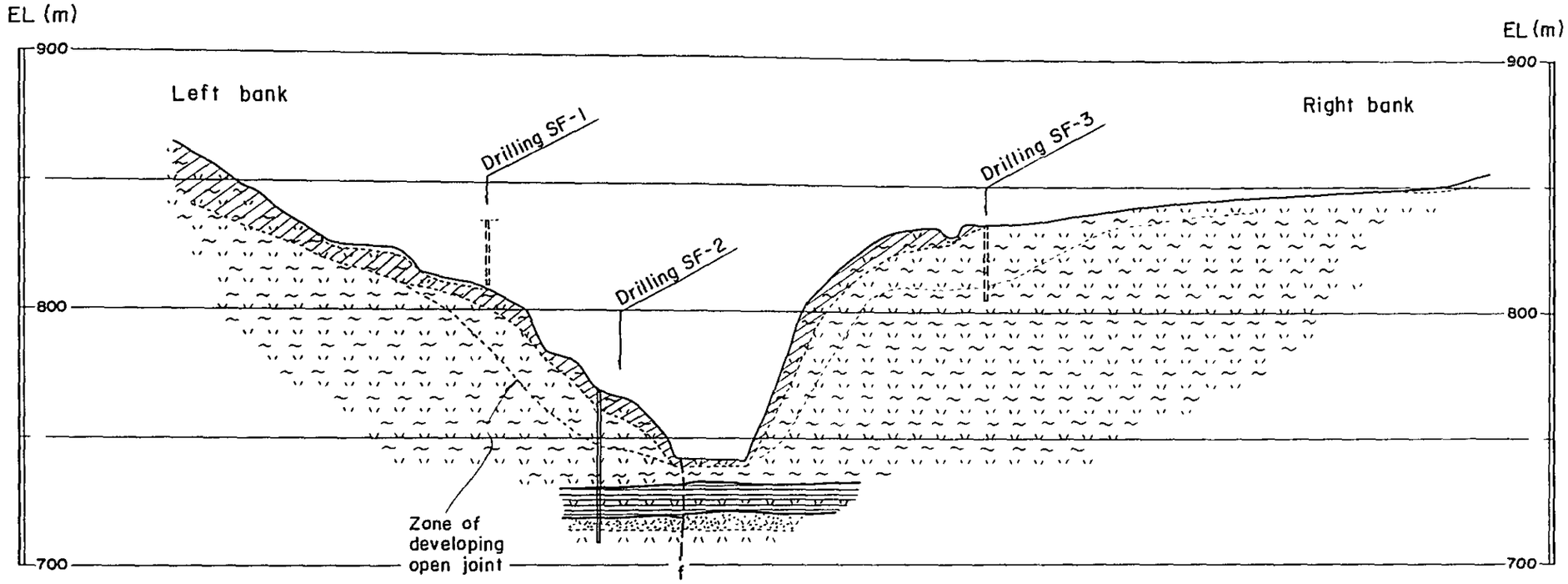
Mapping Symbol	Land Category	Western Plain Area (ha)	Western Plain %	Eastern Plain Area (ha)	Eastern Plain %	Total Area (ha)	Total %
	Upland and paddy field	8,540	38 1	870	6 8	9,410	25 9
	-Sugar cane	(5,170)	(23 1)	(30)	(2 7)	(5,200)	(14 3)
	-Cotton	(740)	(3 3)	(150)	(1 1)	(890)	(2 5)
	-Paddy or rotation of water melon melon sorghum, maize, sesame, etc	(2,630)	(11_7)	(690)	(5 0)	(3,320)	(9 1)
	Pasture land	6,750	30 1	5,880	42 2	12,630	34 8
	Fores land	4,180	18 7	4,700	33 8	8,880	24 4
	Bush and scrub land	490	2 2	550	4 0	1,040	2 9
	Village	420	1 9	290	2 1	710	2 0
	Pond	2,020	9 0	1,610	11 6	3,630	10 0
	Road, water, etc						
	Total	22,400	100 0	13,900	100 0	36,300	100 0

GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES	TITLE OF DRAWING LAND USE MAP OF CHOLUTECA PLAIN
AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	DWG NO 1105
	JAPAN INTERNATIONAL COOPERATION AGENCY

PLATE NO 5

GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES	TITLE OF DRAWING SAN FERNANDO DAMSITE GEOLOGICAL MAP
AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	DWG NO 1201
	JAPAN INTERNATIONAL COOPERATION AGENCY

PLATE NO. 6



Covering of debris and soil

Rhyolitic welded tuff

Shale — Altered tuff

Muddy tuff (solid)

Propylitic tuff (solid)

f — Fault

Intensively weathered or cracky zone

SCALE 0 50 100 m

GOVERNMENT OF THE REPUBLIC OF HONDURAS
MINISTRY OF NATURAL RESOURCES

AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN

TITLE OF DRAWING
SAN FERNANDO DAMSITE
GEOLOGICAL PROFILE

DWG. NO. 1202

JAPAN INTERNATIONAL COOPERATION AGENCY

PLATE NO 7

TALANGA

SAN FERNANDO DAM

RELOCATION OF ROAD 10.0km

RESERVOIR
FWL EL 828500
HWL EL 823500
LWL EL 794500

TEGUCIGALPA

RELOCATION OF HIGHWAY 8.0km

SCALE
0 1 2 3 4 5km

GOVERNMENT OF THE REPUBLIC OF HONDURAS
MINISTRY OF NATURAL RESOURCES

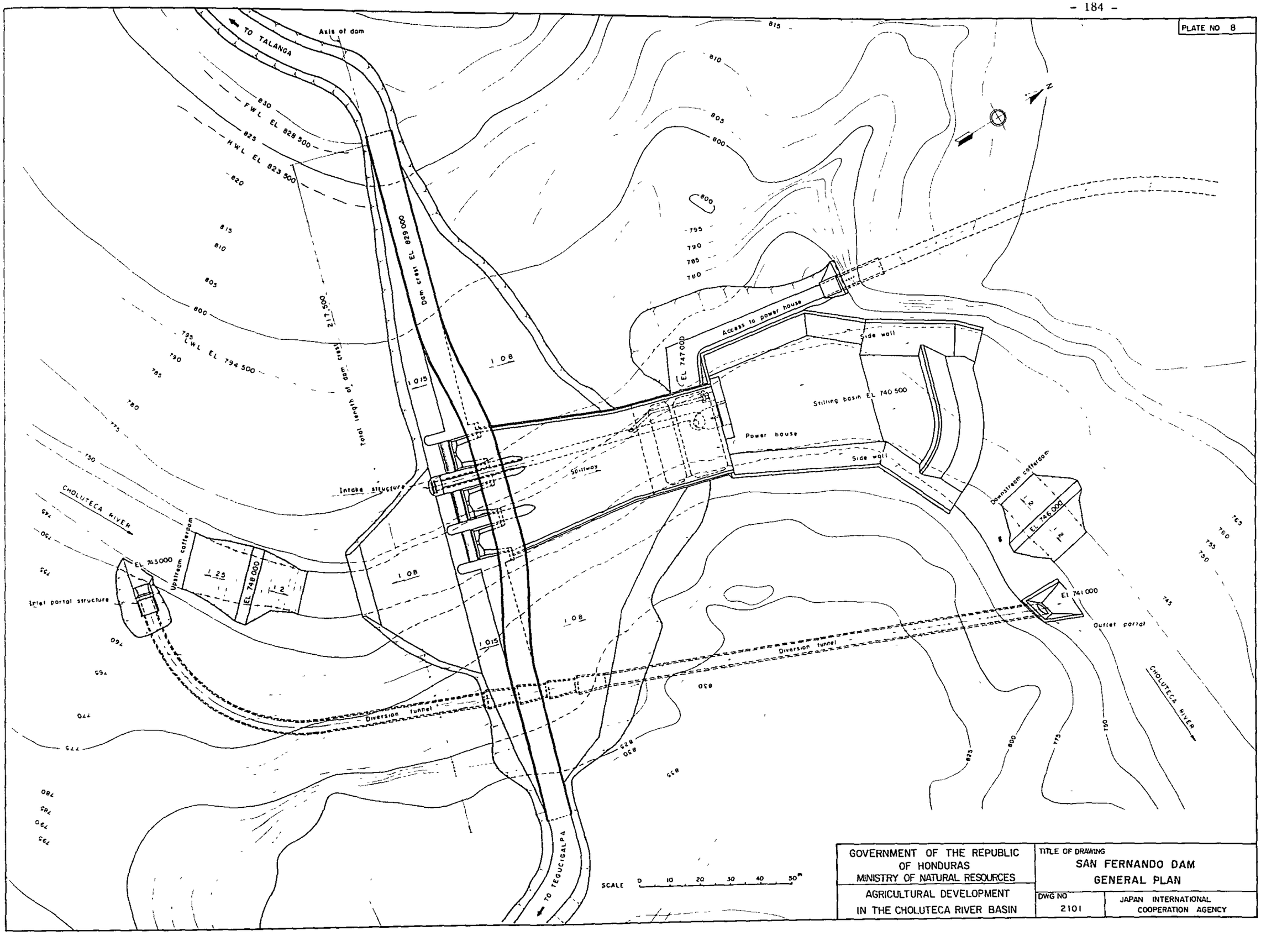
AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN

TITLE OF DRAWING
SAN FERNANDO DAM
VICINITY MAP

DWG NO 2001

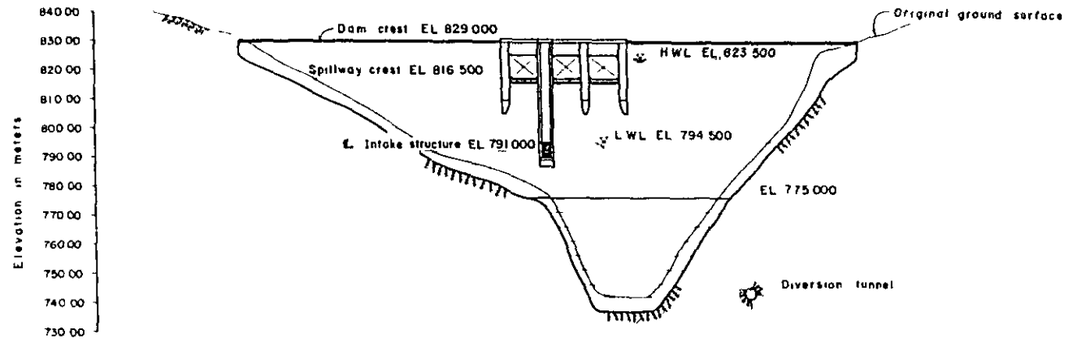
JAPAN INTERNATIONAL COOPERATION AGENCY

PLATE NO 8

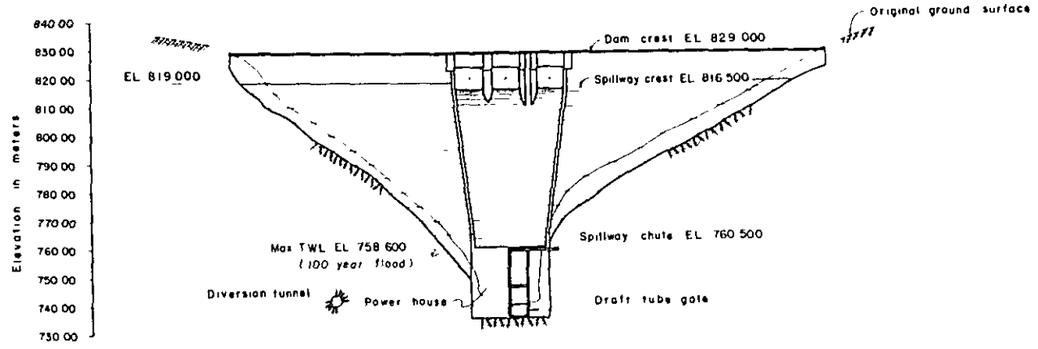


GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES	TITLE OF DRAWING SAN FERNANDO DAM GENERAL PLAN
AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	DWG NO 2101
	JAPAN INTERNATIONAL COOPERATION AGENCY

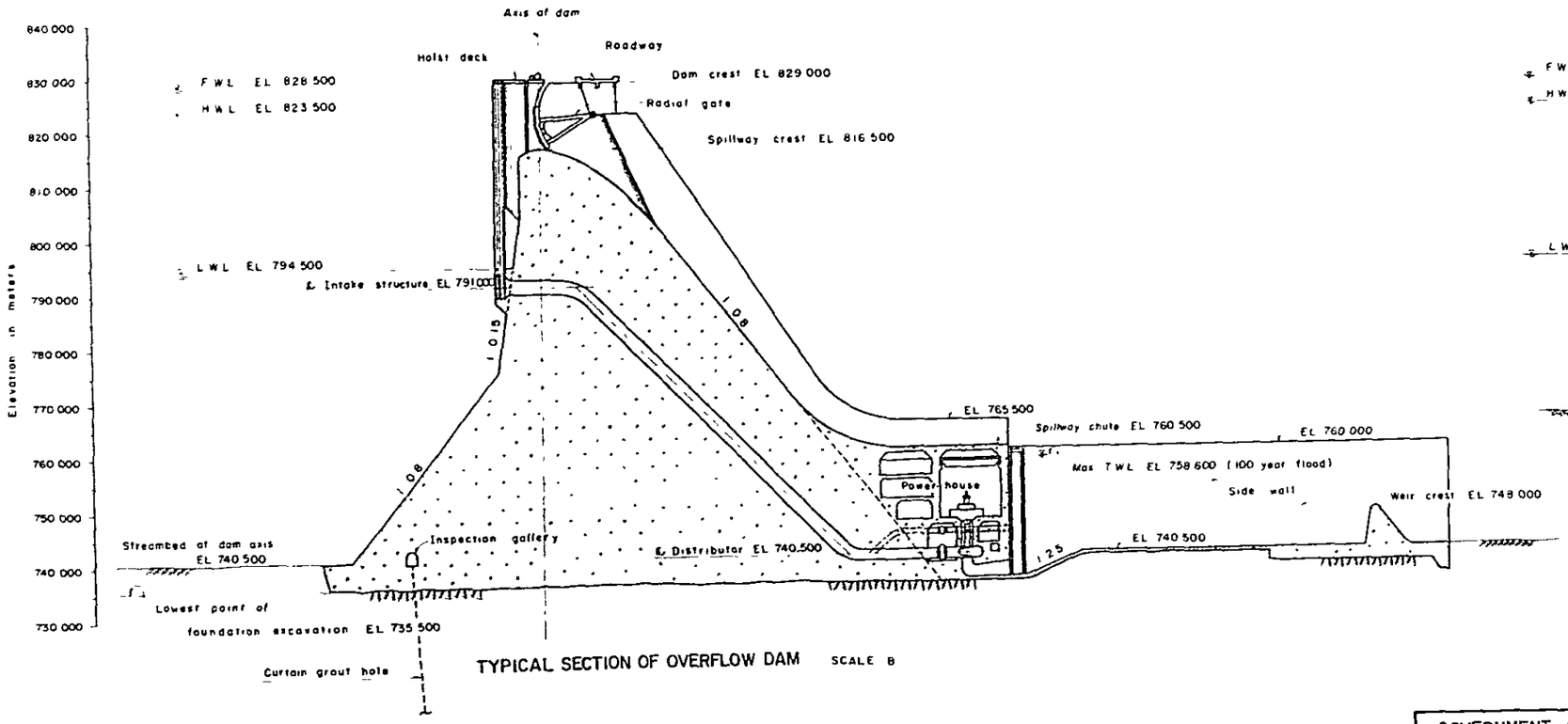
PLATE NO 9



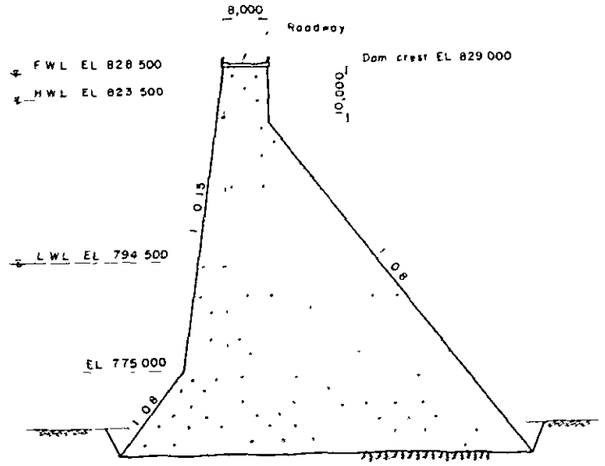
UPSTREAM ELEVATION SCALE A



DOWNSTREAM ELEVATION SCALE A



TYPICAL SECTION OF OVERFLOW DAM SCALE B



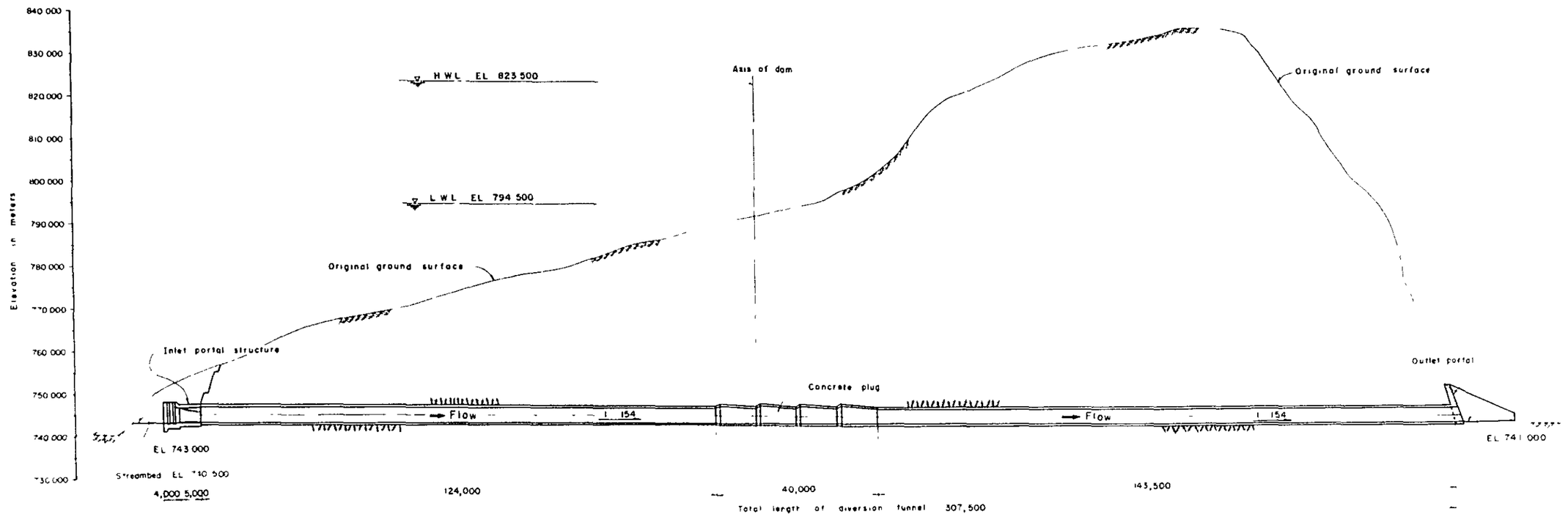
TYPICAL SECTION OF NONOVERFLOW DAM SCALE B

SCALE A 0 50 100m

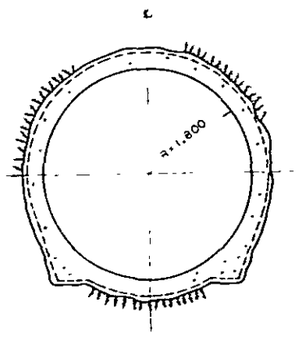
SCALE B 0 10 20 30 40 50m

GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES	TITLE OF DRAWING SAN FERNANDO DAM ELEVATIONS AND SECTIONS OF DAM
AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	DWG NO 2102
	JAPAN INTERNATIONAL COOPERATION AGENCY

PLATE NO 10

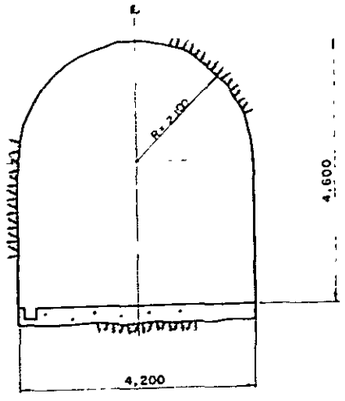


PROFILE ALONG ℄ DIVERSION TUNNEL SCALE A

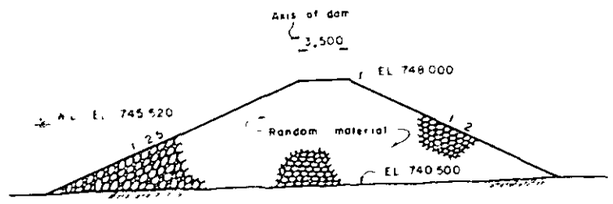


TYPICAL SECTION OF DIVERSION TUNNEL

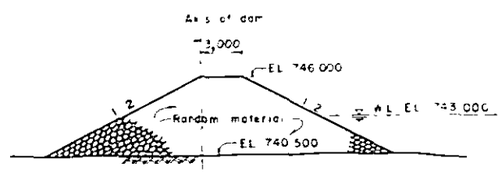
SCALE B



TYPICAL SECTION OF
ACCESS ROAD TO POWER HOUSE SCALE B



UPSTREAM COFFERDAM



DOWNSTREAM COFFERDAM

TYPICAL SECTION OF COFFERDAM SCALE C

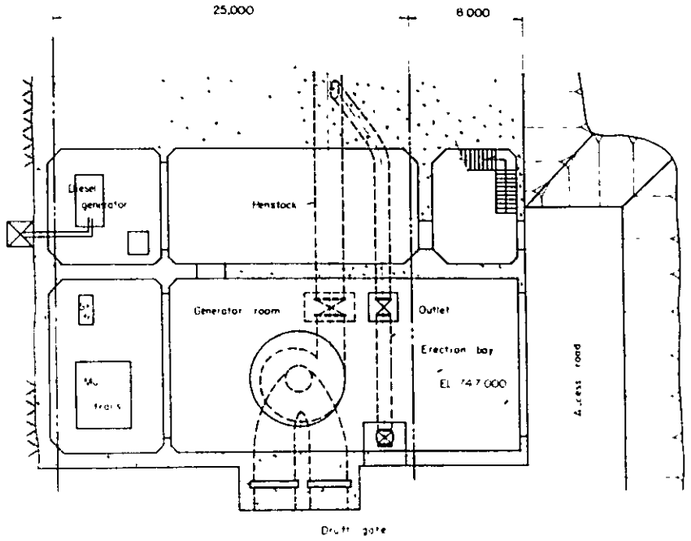
SCALE A 0 10 20 30 40 50 m

SCALE B 0 1 2 3 4 5 m

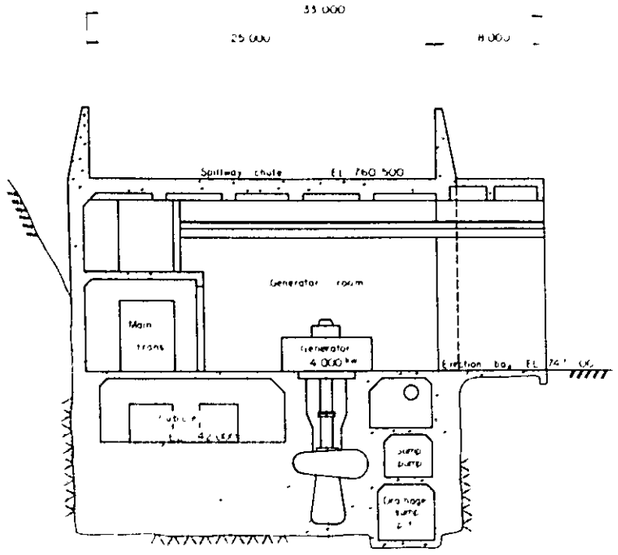
SCALE C 0 10 20 m

GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES	TITLE OF DRAWING SAN FERNANDO DAM PROFILE AND SECTIONS
AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	DWG NO 2103 / JAPAN INTERNATIONAL COOPERATION AGENCY

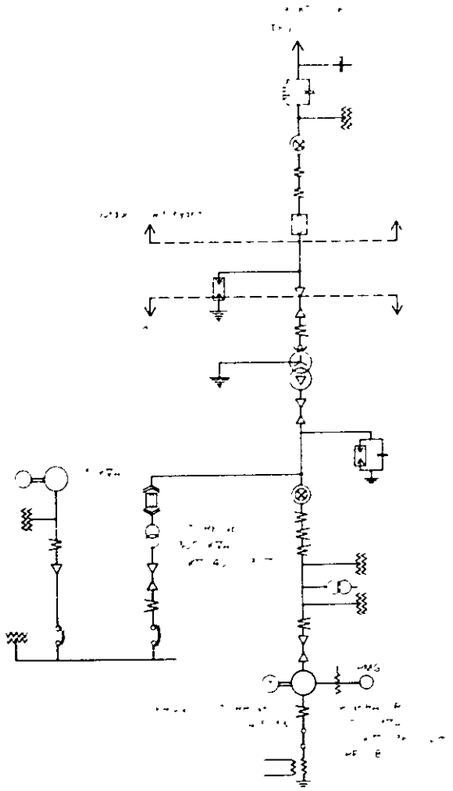
PLATE NO 11



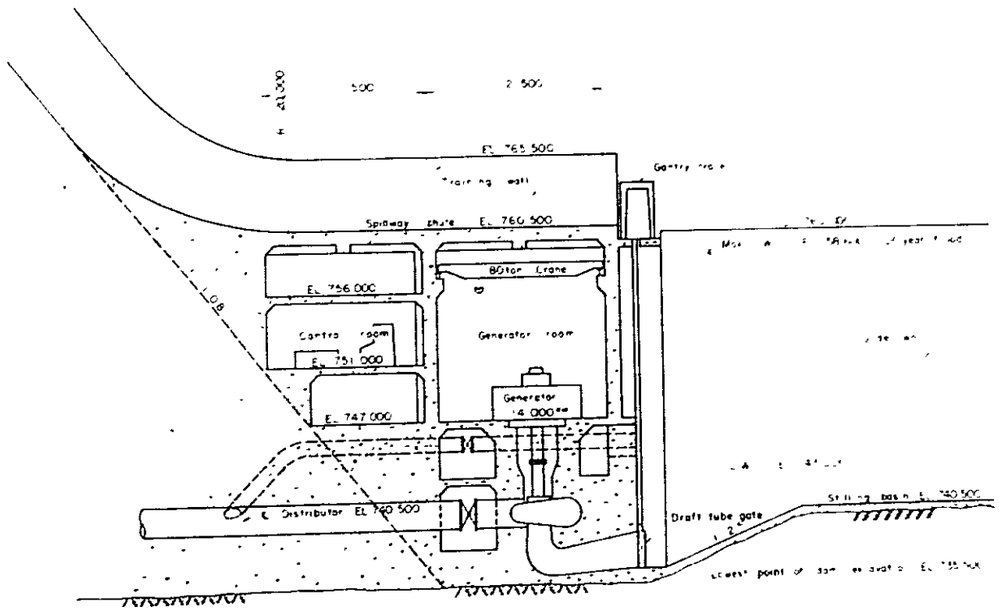
GENERATOR FLOOR PLAN SCALE A



LONGITUDINAL SECTION SCALE A



SINGLE LINE DIAGRAM NO SCALE

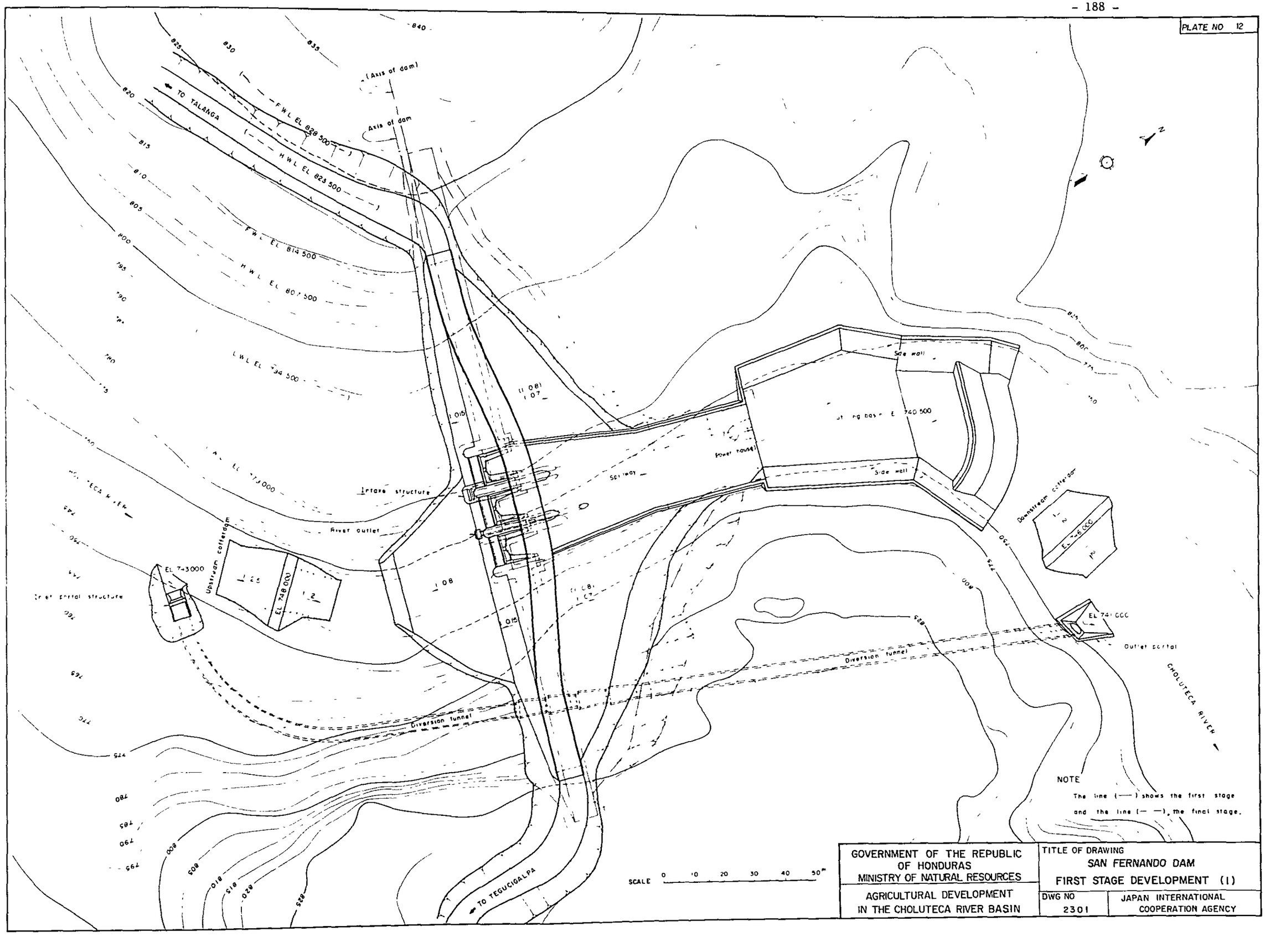


TRANSVERSE SECTION SCALE A

SCALE A 0 10 20m

GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES	TITLE OF DRAWING POWER HOUSE AND SINGLE LINE DIAGRAM
AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	DWG NO 2201
	JAPAN INTERNATIONAL COOPERATION AGENCY

PLATE NO 12

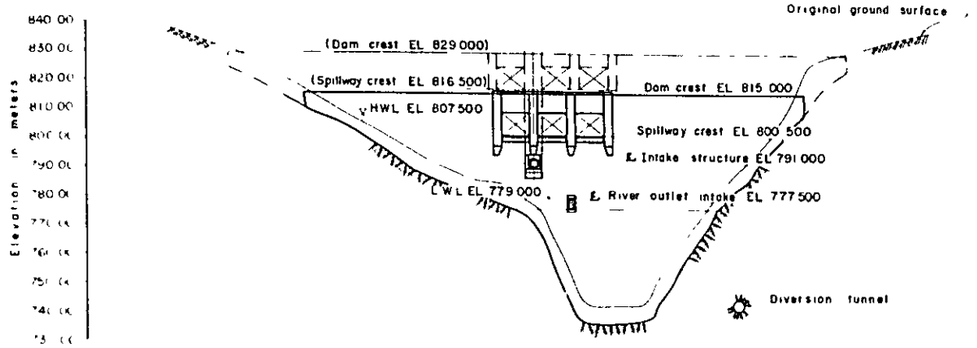


NOTE

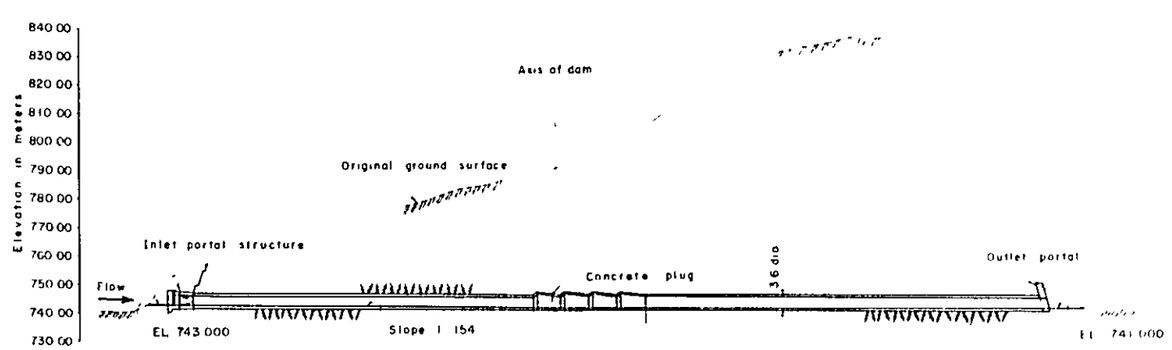
The line (——) shows the first stage and the line (— —), the final stage.

GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES	TITLE OF DRAWING SAN FERNANDO DAM FIRST STAGE DEVELOPMENT (I)
AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	DWG NO 2301 / JAPAN INTERNATIONAL COOPERATION AGENCY

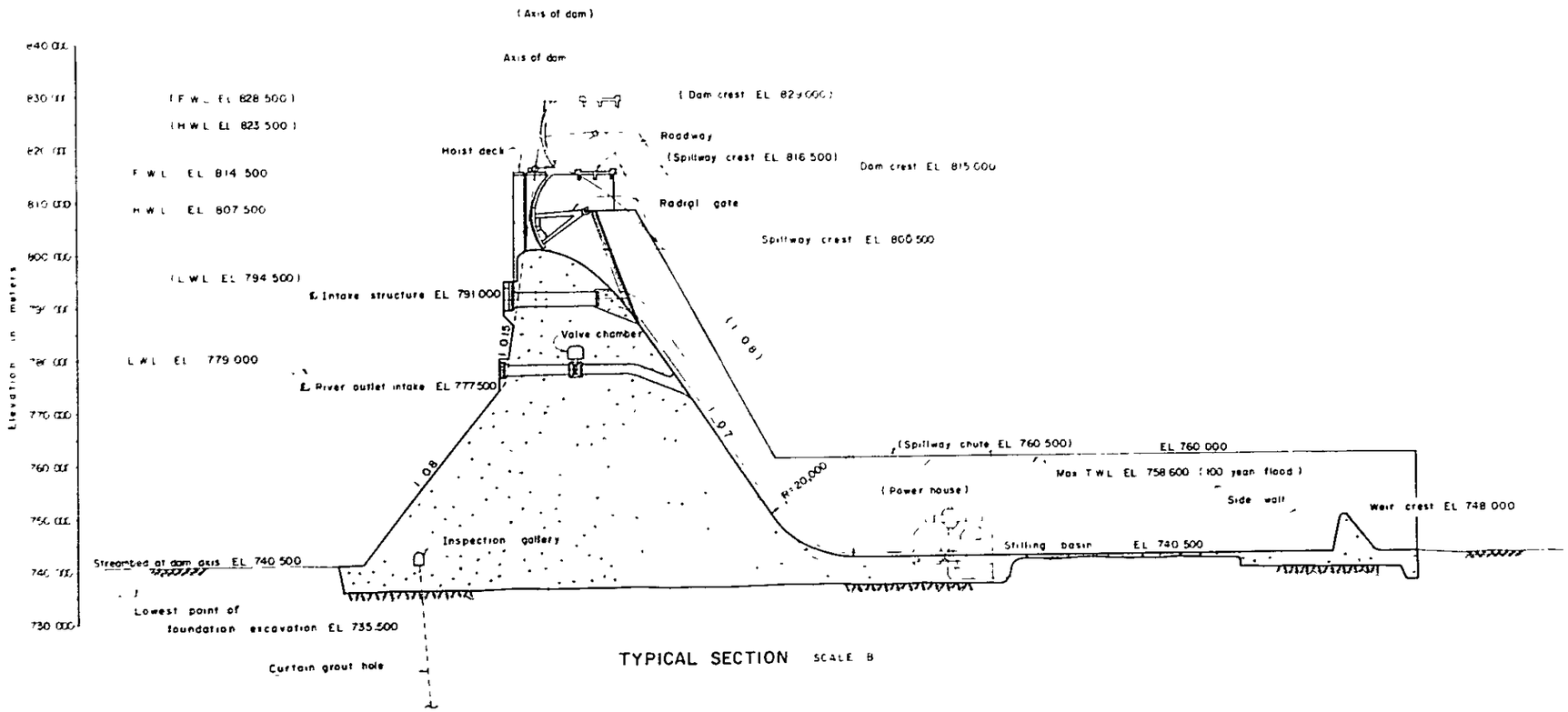
PLATE NO 13



UPSTREAM ELEVATION SCALE A



PROFILE ALONG ℄ DIVERSION TUNNEL SCALE A



TYPICAL SECTION SCALE B

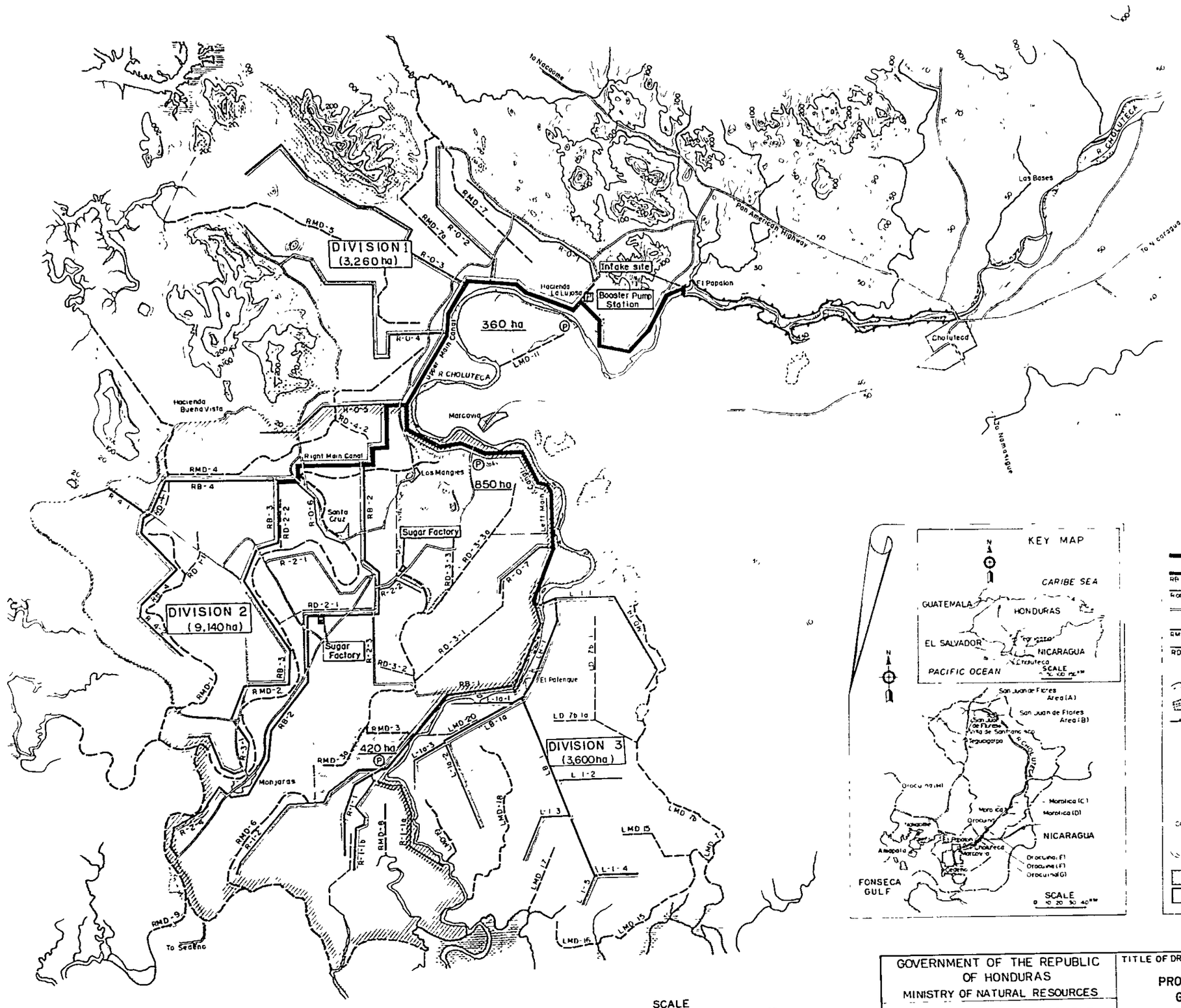
NOTE
The line (——) shows the first stage and the line (— — —) the final stage

SCALE A 0 50 100 m

SCALE B 0 10 20 30 40 50 m

GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES	TITLE OF DRAWING SAN FERNANDO DAM FIRST STAGE DEVELOPMENT (2)
AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	DWG NO 2302
	JAPAN INTERNATIONAL COOPERATION AGENCY

PLATE NO 14



LEGEND

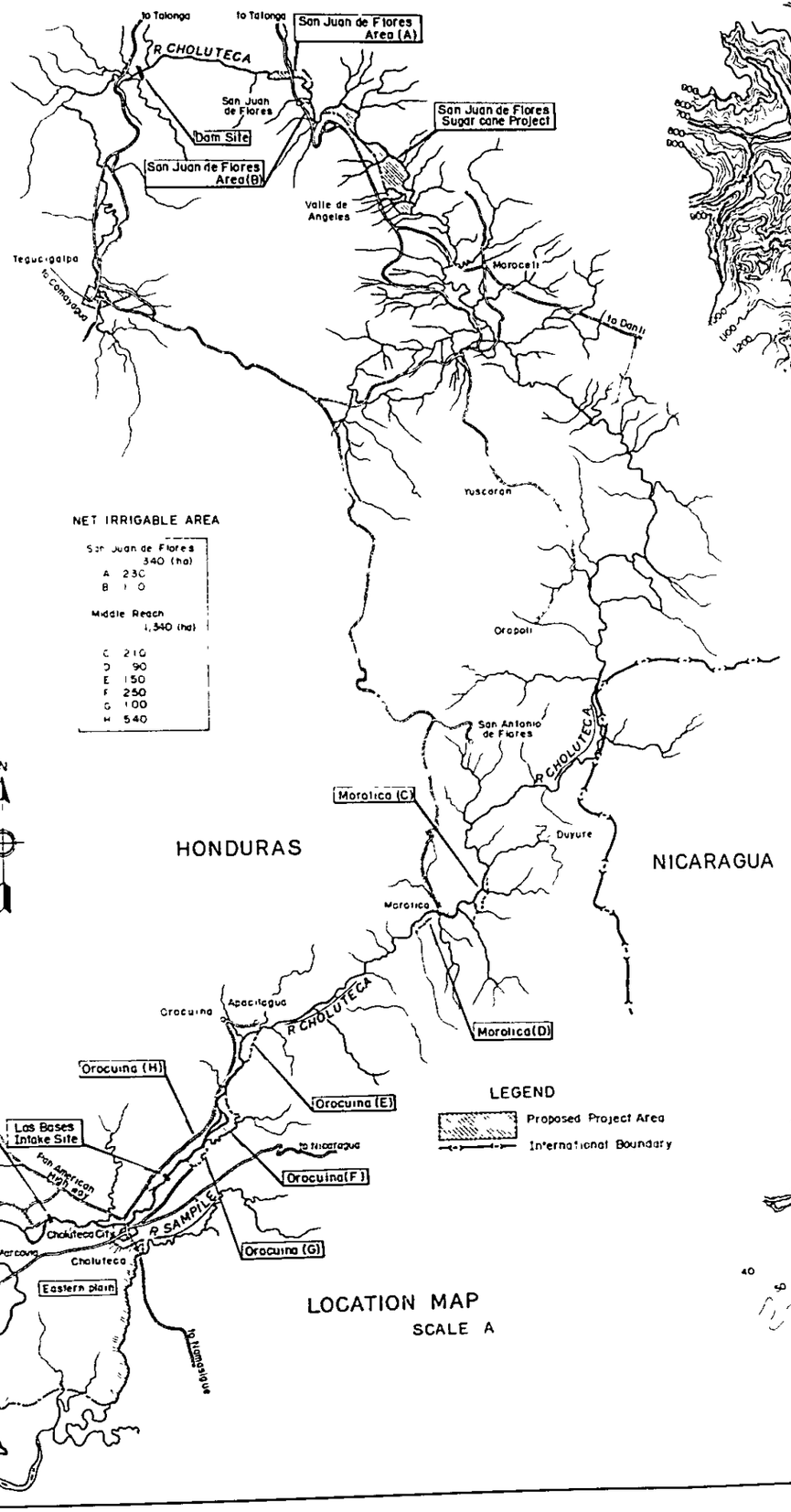
- Main Canal
- Branch Canal (RB or LB 4)
- Secondary Canal (R or L 3 2)
- Road
- Main Drainage Canal (RMD or LMD 5)
- Secondary Drainage Canal (RD or LD 6 7)
- Swamp
- River
- Town
- Dike
- Siphon
- Causeway
- Bridge
- Existing Pump Station (P)
- Weir Site

Contour Intervals
- 100m Contour
- 20m Contour
- 10m Subcontour

- Western Plain Area
- Irrigable area by Existing Pump Station

GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	TITLE OF DRAWING PROPOSED PROJECT AREA GENERAL LAYOUT (I) DWG NO 3001 JAPAN INTERNATIONAL COOPERATION AGENCY

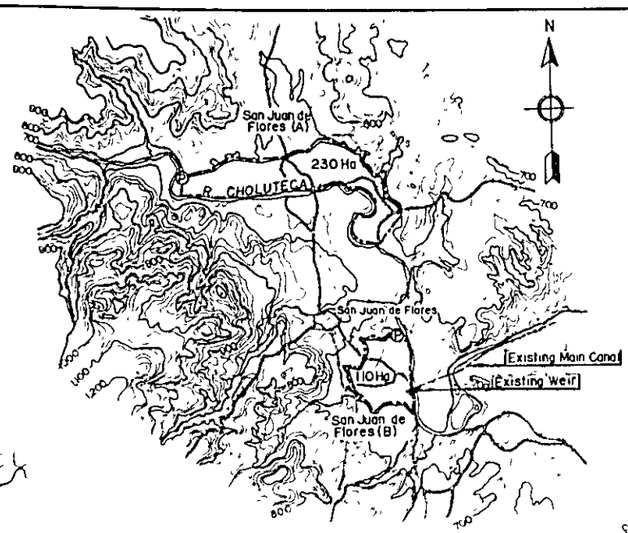
PLATE NO 15



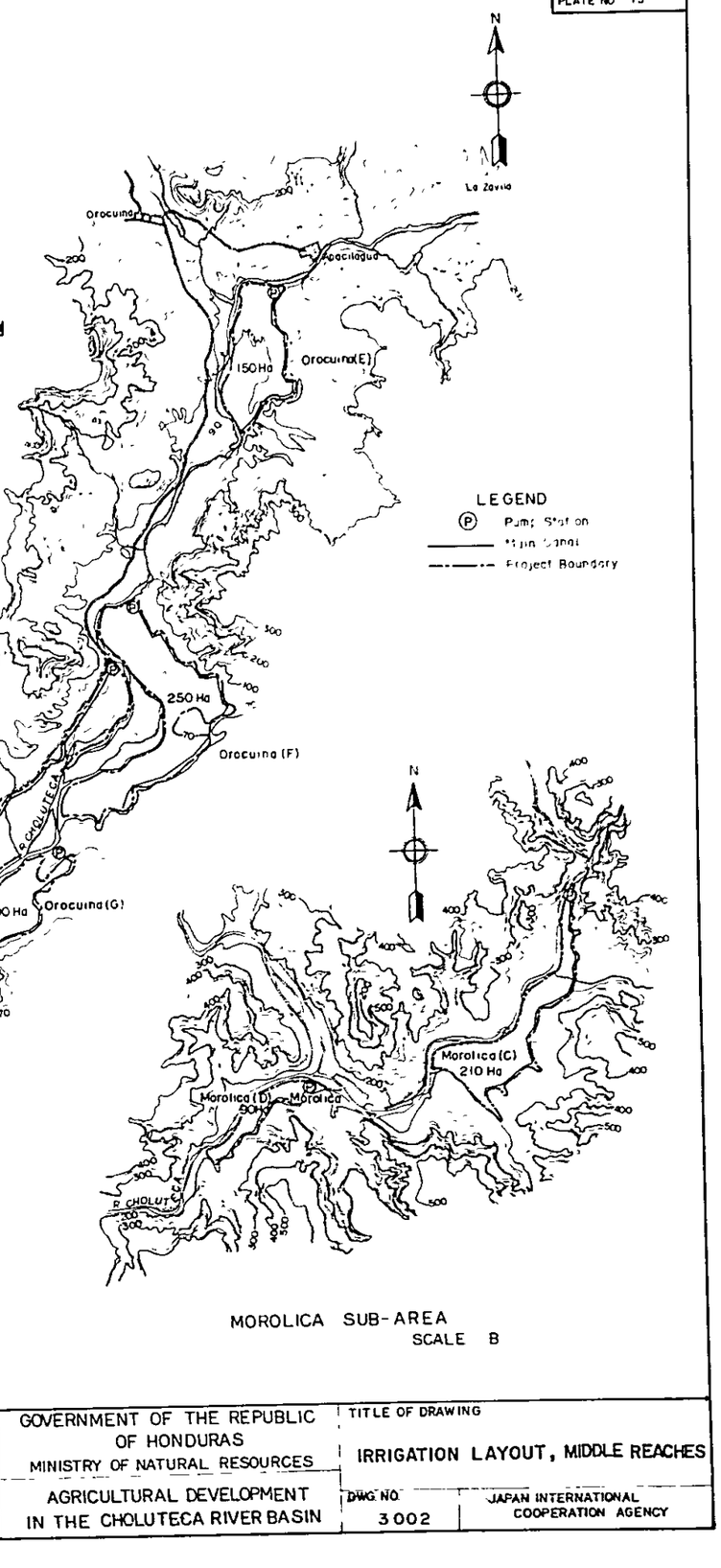
LOCATION MAP
SCALE A

NET IRRIGABLE AREA

San Juan de Flores	340 (ha)
A	230
B	110
Middle Reach	1,340 (ha)
C	210
D	90
E	150
F	250
G	100
H	540



SAN JUAN DE FLORES AREA
SCALE B



OROCUINA SUB-AREA
SCALE B

MOROLICA SUB-AREA
SCALE B

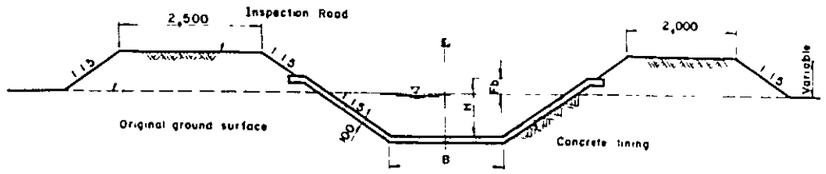
LEGEND
Ⓟ Pump Station
Main Canal
Project Boundary

SCALE A 5 0 5 10 km
SCALE B 0 1000 3000 5000 m

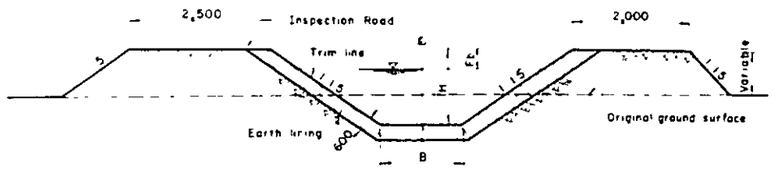
GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	TITLE OF DRAWING IRRIGATION LAYOUT, MIDDLE REACHES DWG NO. 3002 JAPAN INTERNATIONAL COOPERATION AGENCY

PLATE NO 16

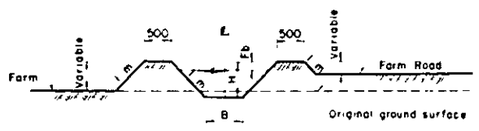
TYPICAL SECTION OF IRRIGATION CANAL



MAIN CANAL

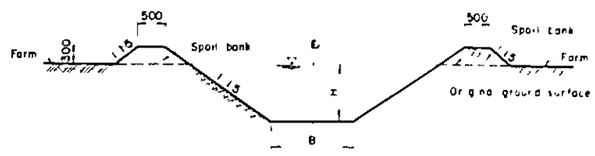


BRANCH CANAL

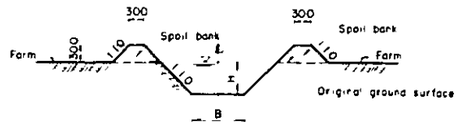


SECONDARY & TERTIARY CANAL

TYPICAL SECTION OF DRAINAGE CANAL

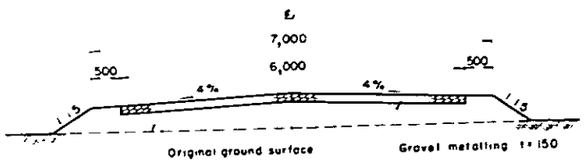


MAIN DRAIN & SECONDARY DRAIN

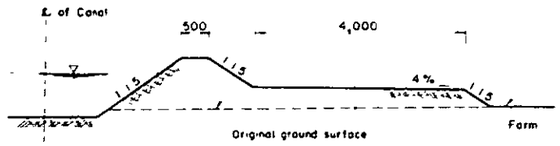


COLECTOR & FIELD DRAIN

FARM ROAD



MAIN FARM ROAD & LINKED ROAD



SECONDARY FARM ROAD

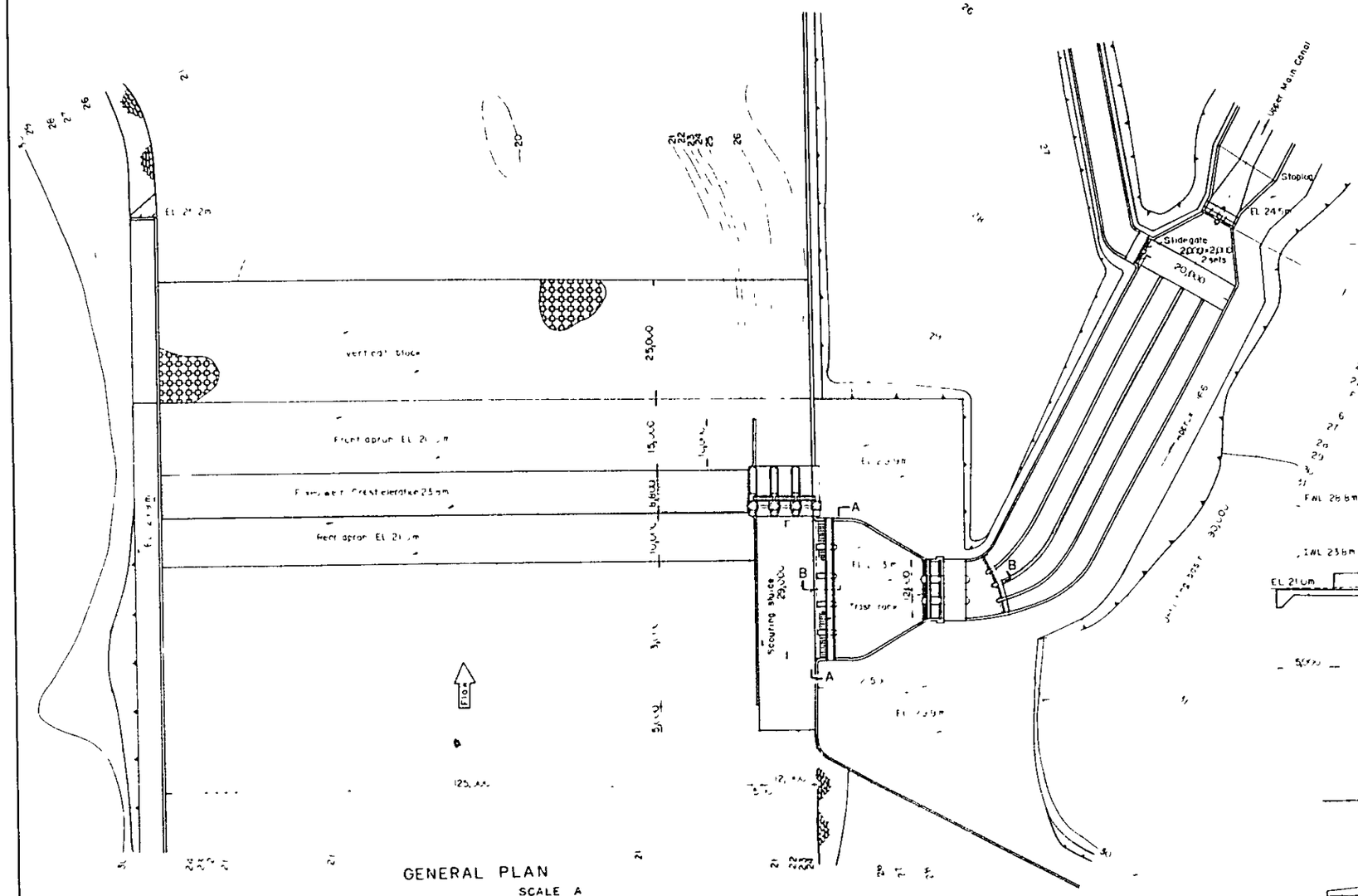
SCALE

SCALE

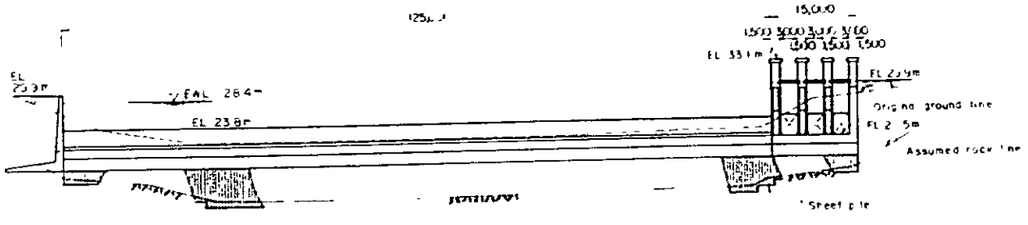
SCALE

GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES	TITLE OF DRAWING IRRIGATION & DRAINAGE CANAL TYPICAL SECTION OF IRRIGATION DRAINAGE CANAL & FARM ROAD	
AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	DWG NO 3101	JAPAN INTERNATIONAL COOPERATION AGENCY

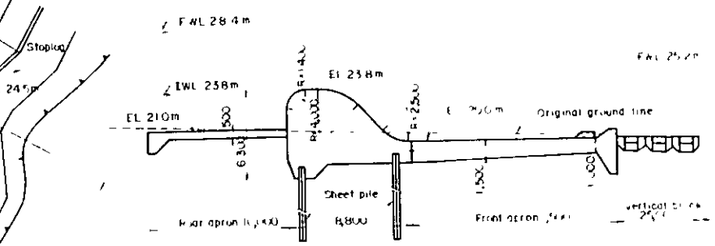
PLATE NO 17



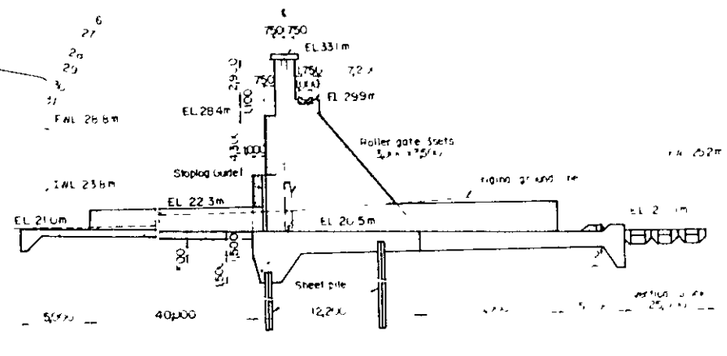
GENERAL PLAN
SCALE A



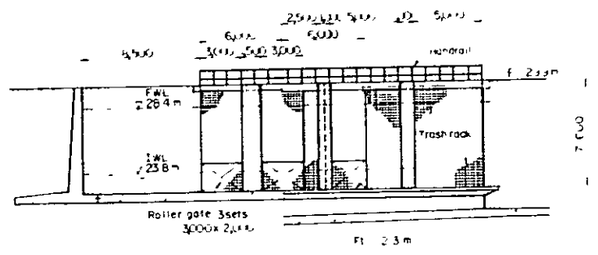
FRONT VIEW
SCALE A



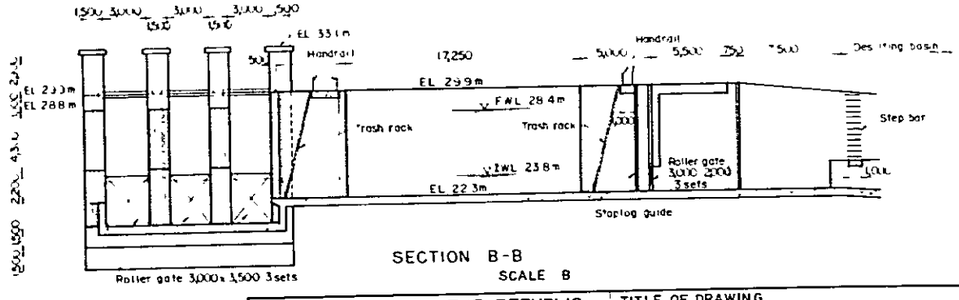
PROFILE (FIXED WEIR)
SCALE B



PROFILE (SCOURING SLUICE)
SCALE B



SECTION A-A
SCALE B



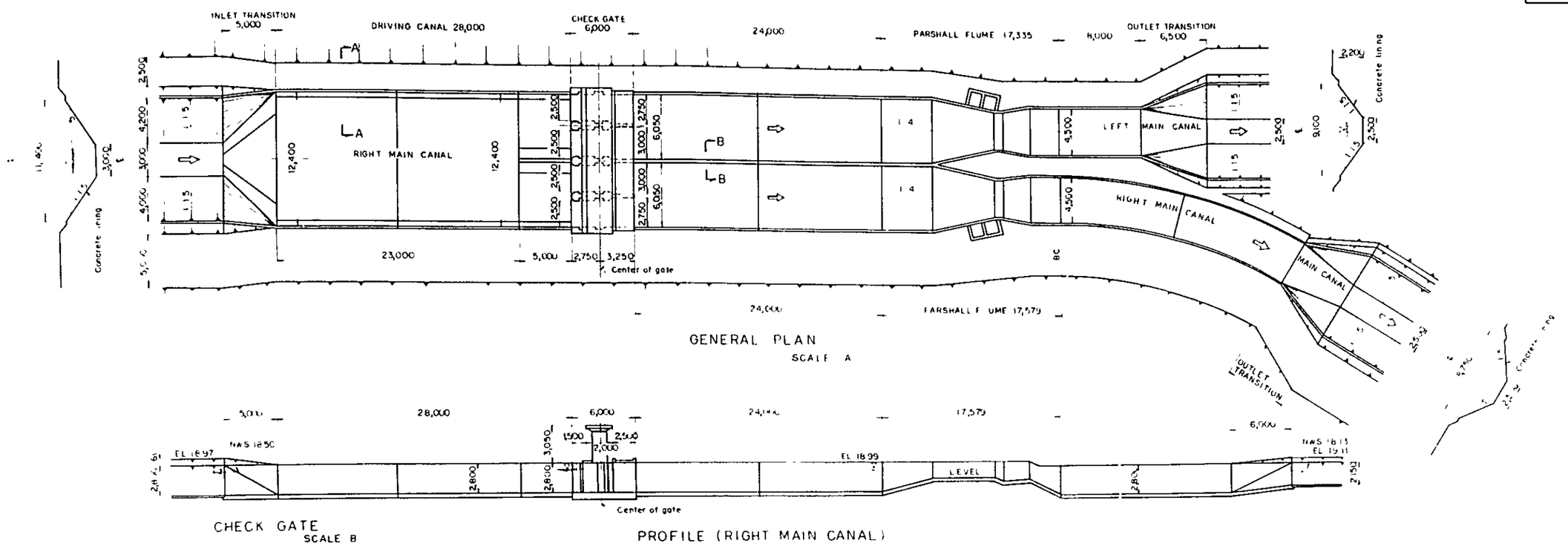
SECTION B-B
SCALE B

SCALE A
0 10 20 30 40 50m

SCALE B
0 10 20 30 40m

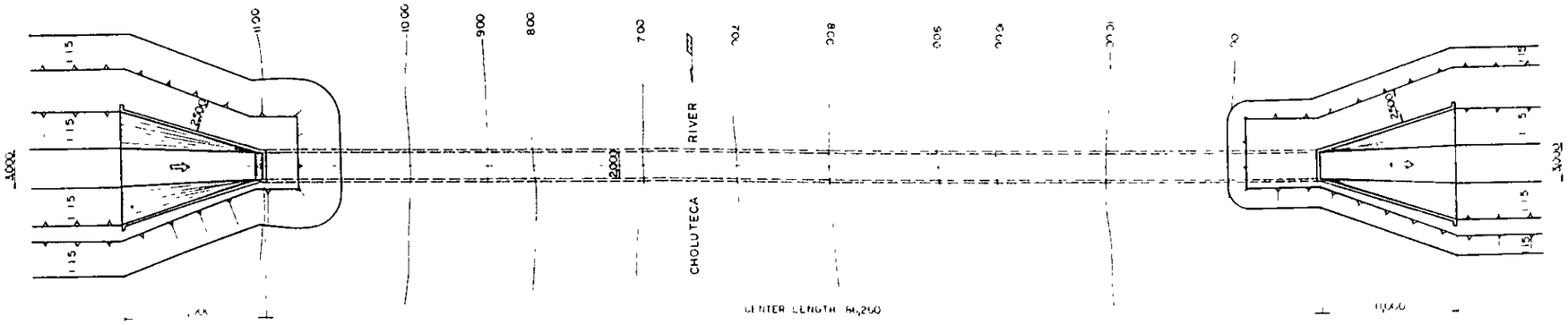
GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES	TITLE OF DRAWING CANAL & ROAD STRUCTURES WEIR	
AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	DWG NO 3102	JAPAN INTERNATIONAL COOPERATION AGENCY

PLATE NO 18

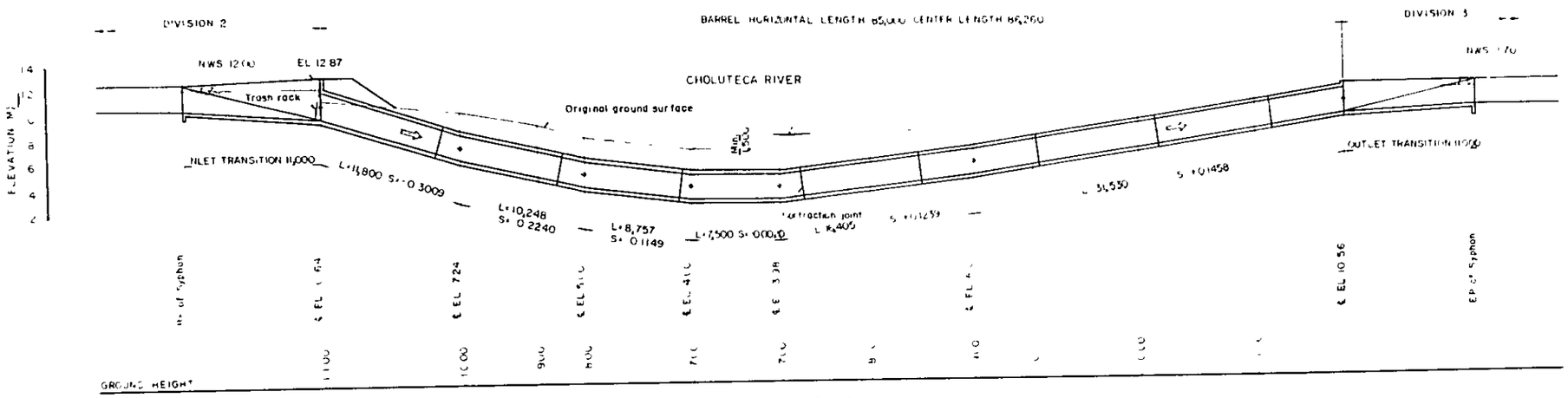


GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	TITLE OF DRAWING CANAL & ROAD STRUCTURES BIFURCATION STRUCTURE DWG NO 3103 JAPAN INTERNATIONAL COOPERATION AGENCY

PLATE NO 19

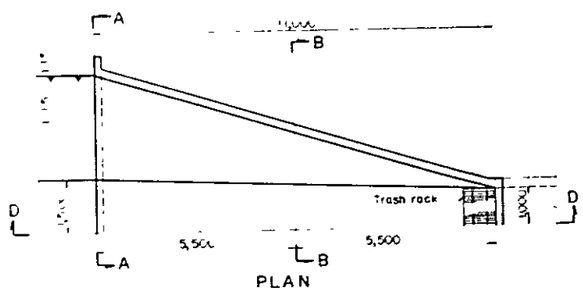


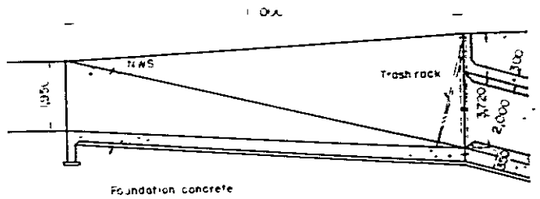
PLAN
SCALE A



PROFILE
SCALE A

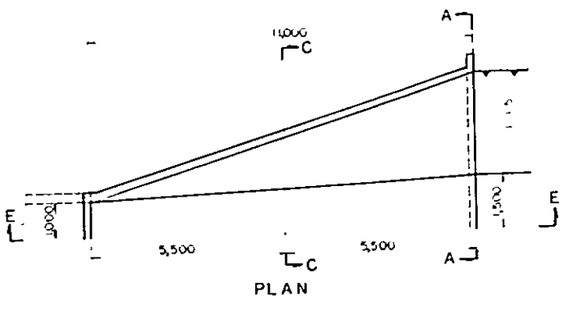
INLET TRANSITION
SCALE B

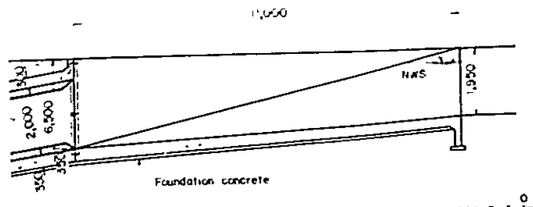




SECTION D-D

OUTLET TRANSITION SCALE B

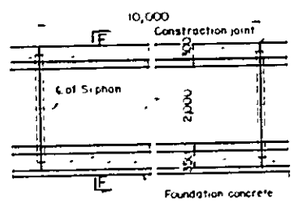




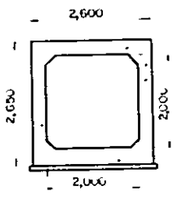
SECTION E-E

SCALE A 0 5 10m
SCALE B 0 1 2 3 4 5m

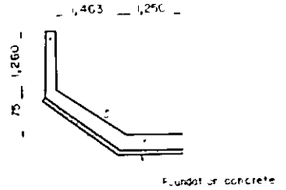
BARREL SCALE B



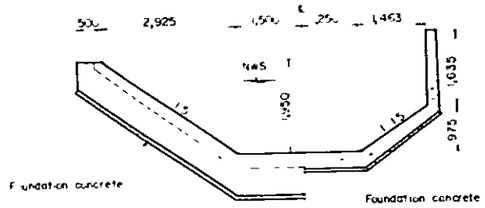
LONGITUDINAL SECTION



SECTION F-F



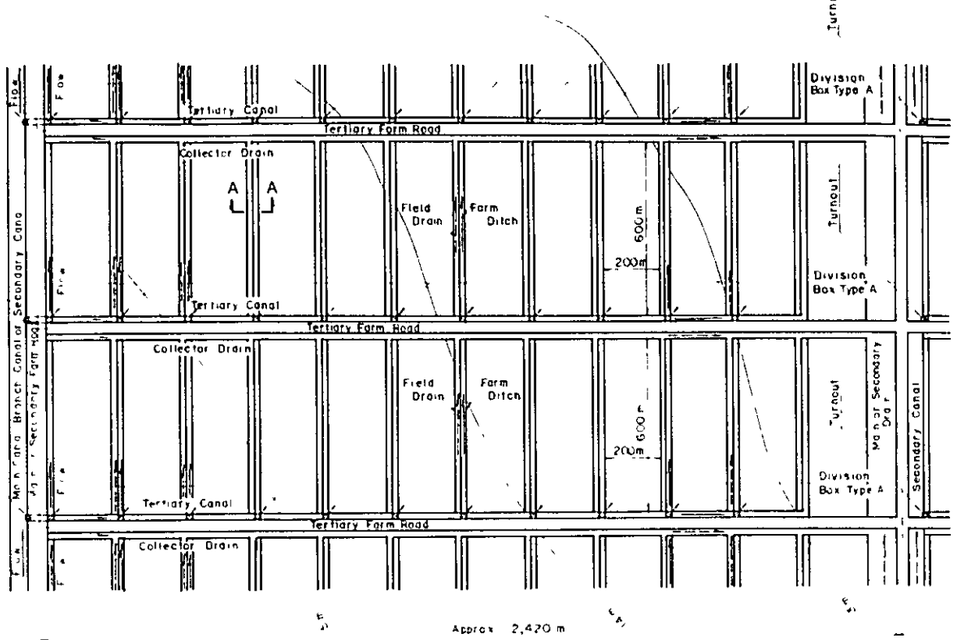
SECTION C-C
SCALE B



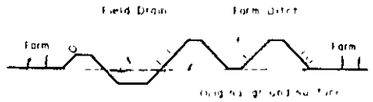
SECTION A-A SECTION B-B
SCALE B

GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES	TITLE OF DRAWING CANAL & ROAD STRUCTURES SIPHON
AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	DWG NO 3104 JAPAN INTERNATIONAL COOPERATION AGENCY

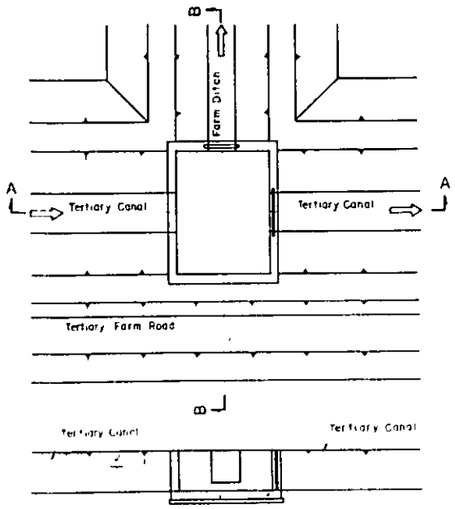
PLATE NO 20



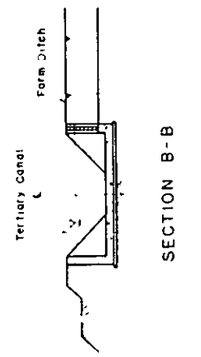
TYPE A

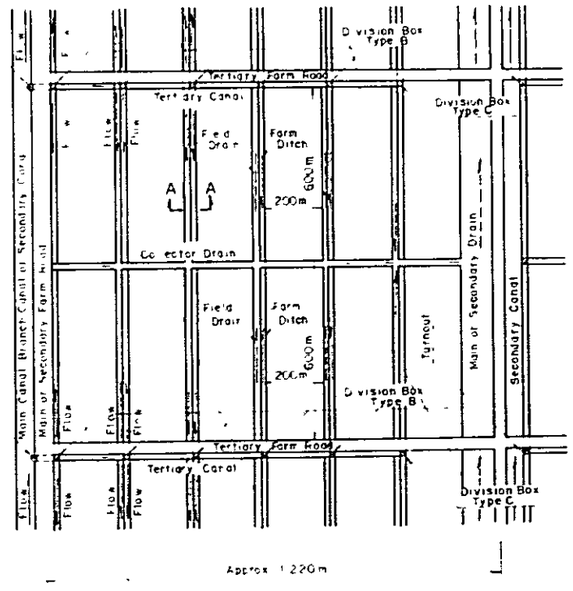


SECTION A-A

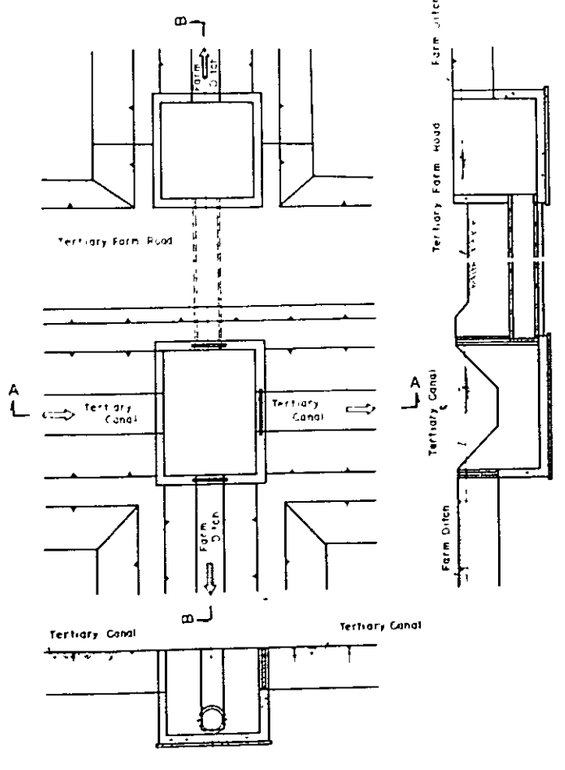


SECTION A-A
TYPE A

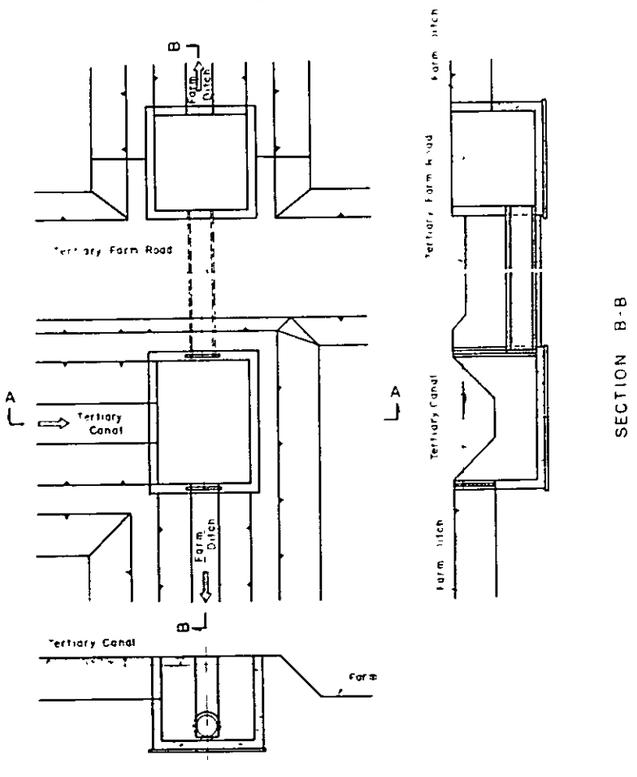




TYPE B



SECTION A-A
TYPE B



SECTION A-A
TYPE C

GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES	TITLE OF DRAWING CANAL & ROAD STRUCTURES TYPICAL FARM LAYOUT AND DIVISION BOX	
AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	DWG NO 3105	JAPAN INTERNATIONAL COOPERATION AGENCY